ANNALS OF SURGERY

VOL. XLI MARCH, 1905 No. 3

ORIGINAL MEMOIRS.

THE DIAGNOSIS AND TREATMENT OF FRACTURE OF THE CARPAL SCAPHOID AND DISLOCATION OF THE SEMILUNAR BONE.

WITH A REPORT OF THIRTY CASES.

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IT is proposed to consider the subjects included in the title of this paper under the following heads:

I, Introduction. II, Development of the Carpal Bones. III, Symptoms of Simple Fracture of the Scaphoid Bone. IV, Diagnosis. V, Use of the X-ray in Diagnosis. VI, Treatment of the Fractures of the Scaphoid. VII, Report of Cases. The remarks upon these groups constitute the present paper. In a second paper will be presented, I, Dislocation of the Semilunar Bone. II, Symptoms. III, Treatment. IV, Report of Cases. V, *Résumé* of Literature of Carpal Injuries in General. VI, Diagnosis and Treatment. VII, Report of Cases. VIII, Conclusions. IX, Bibliography.

PART I.

INTRODUCTION.

The first case of simple fracture of the scaphoid bone of the wrist in which I was able to make a diagnosis was that of J. G. (Case I), which is herewith reported. For the privilege of reporting this case, as well as several others, I am indebted to Dr. Franklin G. Balch, in whose Clinic at the Massachusetts General Hospital J. G. was treated. In this instance the diagnosis was considered a simple sprain, but the continued symptoms led us at length to examine the wrist with the fluoroscope, and the fracture was then easily recognized. During the next four years occasional examples of this lesion presented themselves at the Clinic, but it was not until a private case (Case V) came to me in December, 1901, that I fully appreciated the importance of this fracture. The failure of rest, time, massage, and, finally, of forcible manipulation to restore the perfect functions of this young man's wrist, has led me to study with great care all the other cases of carpal injuries which I have met in my hospital work. As a result of this study, I now recommend excision of one or both portions of the broken scaphoid. The cases herewith reported have nearly all been at my own Out-Patient Clinic; but for a few I am indebted to my colleagues, who, knowing my interest in injuries to the wrist, have referred them to me. Besides the cases here reported, there have been many others which I have seen once or twice and which help to form the experience on which this paper is based. Dr. Chase and I have, however, felt that partial reports of such cases would be superfluous, because the ultimate results have not been observed or because the X-rays have been obscure and doubtful. We have, therefore, selected those cases to report which we have in most instances been able to observe for some months or years after their original injury.

My interest in this subject is also greatly quickened by a friendly discussion with Professor Thomas Dwight, in which a radical difference of opinion has arisen as to the nature of

these fractures of the scaphoid. My views have been based on my clinical and X-ray experience, and I consider these lesions as entirely due to trauma acting on normal bones. I explain the non-union by the anatomical situation of the bone, which allows the fractured surface to be persistently bathed in synovial fluid, and by the lack of proper and continued fixation immediately after the injury. Professor Dwight, looking at the subject from a developmental and anatomical point of view, explains these lesions as instances of bipartite centres of ossification which never unite by a true bony union, and thus are easily separated by violence. In an address to the Massachusetts Medical Society, his words, referring to certain anomalies in the formation of bones, are as follows: "This naturally suggests the burning question of fracture of the scaphoid bone of the wrist, which I think no one had ever heard of before the X-ray. Now it occurs all the time. My friend Dr. Codman was kind enough a while ago to show me a room full of patients with fractured scaphoids at the Massachusetts General Hospital; and yet I still believe that, putting aside extraordinary cases of injury, a normal scaphoid is never broken, and that the separation into two parts, which undoubtedly occurs, is the result of violence acting on a bone composed of two pieces united merely by cartilage. This also I hope before long to establish." Certain bipartite scaphoids which Professor Dwight finds in the dissecting-room, he considers as examples of such faults of development, while from my point of view they are merely instances of the fairly common lesion of fracture of the scaphoid (Plate IV, Fig. 12).

In following up this subject, another lesion of the wrist of slightly less frequent occurrence has been met with, and it has seemed to us necessary to include this with simple fracture as it sometimes accompanies it. We have, therefore, included dislocation of the semilunar bone under the scope of this paper, particularly since a method of reduction, devised by one of us in pursuance of some anatomical studies of the normal motions of the wrist-joint, has been used with signal success in three cases.

During our study of these two typical lesions, *i.e.*, simple fracture of the scaphoid and dislocation of the semilunar bone, we have met with a few other instances of fractures of the small bones of the carpus; but, since they were extremely rare, we have left them out of the discussion, feeling that it is more important to call the attention of the profession to these two more common lesions, which are really so often met with that they should be borne in mind by every practitioner, and are by no means to be considered as curiosities.

That error in the diagnosis and treatment of these injuries is frequent is well illustrated by four articles which have appeared in this Journal during the last four years. I refer to those by Bolton, Stimson, Hessert, and Ely, criticism of whose papers, except that by Bolton, will be found in the foot-notes in Part II under names of Stimson, Hessert, and Ely.

In Bolton's case, as in the others, the error is one of interpretation of the skiagraph, which shows, in addition to the obvious dislocation of the semilunar, a coincident fracture of the scaphoid bone. (E. A. C.)

DEVELOPMENT OF THE CARPAL BONES.

It is not our intention to enter into the discussion of the detailed comparative anatomy or embryological history of the centres of ossification of the carpal bones, but we feel that a brief mention of the theory of Pfitzner is important in giving a fair presentation of our views on the relative frequency of fracture of the scaphoid and of a congenital bipartite condition of this bone. Pfitzner, having studied the types of arrangement of the carpal bones in the lower animals, has elaborated the following typical scheme of the probable centres of ossification, the fusion or coalescence of which forms the variations in different species. This scheme conceives the formation of cartilaginous centres, twenty-four in number, which represent the possible number of carpal bones which may develop through the independent ossification of each centre. Variations from this type are caused by disappearance of certain centres, by absorption, by absence of ossification, and by fusion or

coalescence of the different elements. This may be more clearly appreciated by reference to the accompanying diagrams of Pfitzner (p. 326), which represent the cartilaginous centres of the possible bones of the carpus and suggest two interesting considerations.

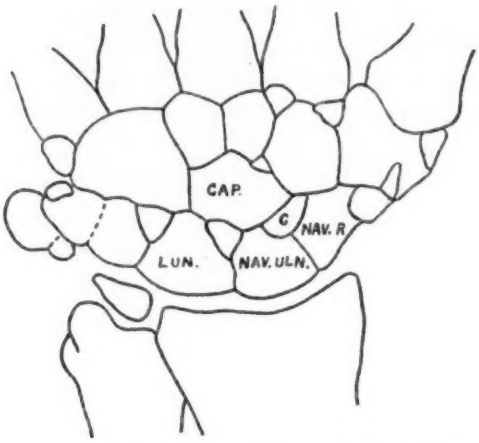
First, an arrangement roughly into five rows suggests its homologous relation to its ancestral types; second, the number of centres represent the possible number of the adult carpal bones, some of which, as a rule, disappear, and do not continue development to ossification, while others either coalesce and form a process or continue an independent existence as a separate bone.

The ages at which the centres of ossification of the carpal bones appear have been recorded by Debierre as follows:

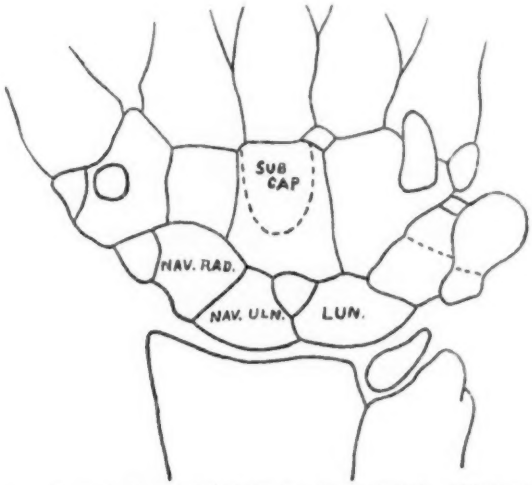
Os magnum, 11 to 12 months; unciform, 12 to 14 months; cuneiform, 3 years; semilunar, 5 to 6 years; trapezium, 6 years; scaphoid, 8 years; trapezoid, 6 to 7 years; pisiform, 10 to 13 years. But these have been found to occur somewhat earlier since the use of the X-ray, and both observations suggest that we must not expect fracture to show in early life.

Pfitzner emphasizes the rationality of his theory by showing several instances of variation in which a single centre of ossification is found in each of three specimens, either as a distinct bone or coalesced to one of its adjacent carpal bones forming a bone process. He stated also that, although he had never seen a separate centre for a bone which he called the subcapitatum (marked Subcap. on the diagram), he nevertheless was firmly convinced that it must exist in harmony with the rationality of his theory and practically proven scheme of the development of carpal bones. This great anatomist died without ever having seen this one separate bone, the subcapitatum, which he prophesied must exist. He described the subcapitatum as lying on the palmar side of the hand between the trapezoid and the unciform bones, synostosed with the distal portion of the os magnum and articulating with the third metacarpal. This bone was first recognized and beautifully

demonstrated by Professor Thomas Dwight in both hands of a white man aged fifty-four years, thus adding another con-



Pfitzner's diagram. Dorsal view. NAV. R., Navicular Radiale. NAV. ULN., Navicular Ulnare. C., Centrale. LUN., Lunatum. CAP., Capitatum.



Pfitzner's diagram. Ventral view. NAV. RAD., Navicular Radiale. NAV. ULN., Navicular Ulnare. LUN., Lunatum. SUBCAP., Subcapitatum.

firmation of Pfitzner's scheme and speaking loudly for its acceptance.

To speak now more particularly of the possibilities of variation of the scaphoid bone, we refer to Pfitzner's diagram of the navicular (scaphoid), which he has termed the navicular radiale and navicular ulnare in harmony with his view of two centres. It is the development of a centre of ossification in each navicular radiale and ulnare that gives rise to the so-called bipartite scaphoid; and it is the additional centre of ossification in the centrale which gives rise to the more rare condition of tripartite scaphoid.

Woolf considers two centres of ossification uncertain and not the rule, as Gruber thinks. American anatomies and embryologies state the rule as one centre. Serres recognizes Pfitzner's entire theory of three centres of the scaphoid, which as a rule unite to form one bone. Leboucq never saw more than one centre, which is of value, as he has made important discoveries about the development of the hand. Behrendsen and Von Ranke do not mention two centres. Von Wyss saw in cretins two centres in the scaphoid, but we do not know his view regarding normal individuals. Wilms never saw two centres from birth to adult. Gruber states that from 1869 to 1883 he saw 3007 scaphoids in which four were bipartite and one was tripartite. Since 1883 he speaks of 1000 scaphoids in one of which were traces of tripartite. Pfitzner in 1450 scaphoids saw one-half per cent. of entire divisions, but he does not make it clear that some, if not all, of these might not have been old fractures. Among the 1450 he also saw 2 per cent. to 3 per cent. of fissures. In looking through 1040 X-rays of wrists, we do not find any divided scaphoid which is not definitely associated with injury, even in those in which X-rays of both wrists were taken for comparison.*

It is our position in this paper that we have not sufficient knowledge of embryology or comparative anatomy to presume to argue with Professors Pfitzner and Dwight on their own

* There are three possible exceptions to this statement (Cases II, IV, IX). While in these cases the patient could give no history of injury, the presence of secondary arthritic changes and pronounced clinical symptoms speak strongly for the traumatic origin of the lesion.

grounds; yet it has not been made clear that a part, if not all, of the divided scaphoids above mentioned may not have been the result of old fractures. We do not wish to assume that variations do not occur; there is no reason to believe that nature does not vary in the formation of the carpal bones as well as in any other part of the body; but we do wish to show that while they may occur, and while we do have to consider the possibility of their presence in any case under observation, nevertheless, they are rare, much more rare than fracture. We wish the possibility of variation understood and appreciated to aid judgment in its interpretation of clinical history.

If the bipartite variation is sufficiently frequent to be a real cause for confusion with fracture, it is a surprising coincidence that no X-rays of wrists taken for other conditions, such as foreign bodies or injuries to the forearm and phalanges as well as many normal wrists taken unnecessarily in a large number of cases, show no bipartite scaphoids.

Woolf cites a case which harmonizes with our views of rare possibilities. It was one which he diagnosed as a bipartite scaphoid; it was bilateral; there was no history of injury; there were no disabling clinical symptoms; forcible abduction showed no dislocation of fragments. He concludes that a part of the so-called bipartite scaphoids are fractures without bony consolidation, simulating other intracapsular fractures. One can only accept the bipartite theory where the halves touch with smooth cartilaginous surfaces. In the cases in which we have operated this was not found to be the case.

The cases illustrating this paper we believe are positive fractures. We say positive, because their diagnoses are based upon a series of definite observations, supported by circumstances of causation, and associated with objective and subjective symptoms, giving a clinical picture which it is not reasonable to accept as happening fortuitously on a previously developed bipartite scaphoid, so accurately harmonizing in every detail with the particular right or left hand in which trauma and local symptoms coincide, and in none of which do both wrists show the same condition.

Variations exist and deserve recognition, but they do not exist so regularly and unilaterally as to coincide in each case with the associated cause of fracture, the objective and subjective symptoms, as to lead one to assume any selective motive for injury to the particular wrist containing a bipartite scaphoid.

In confirmation of our opinion, we find in some of our cases that union has occurred as shown strikingly by the X-rays in Case VI.

SYMPTOMS OF SIMPLE FRACTURE OF THE SCAPHOID BONE.

The cases of fracture of the scaphoid which are herewith reported have, with a very few exceptions, presented themselves from several months to many years after the original injury, so that the history and symptoms should more properly be considered as those of old ununited fractures of the scaphoid than of the recent injury. The typical history has been something like the following, and is frequently characteristic enough to permit of diagnosis even without the X-ray.

The patient, usually a male of from twenty-five to thirty-five years of age, has fallen on his extended wrist in the same manner as in the injury which usually causes a Colles fracture. He has supposed that he has sprained his wrist, and for a few days has suffered severe pain and tenderness and has been unable to use the hand for ordinary purposes. During a period varying from a few days to several weeks, according to the hardihood of the individual, he has refrained from using his wrist. Gradually he has been able to take up his work again, but after a certain point the soreness, tenderness, and disability have refused to improve, and perhaps he has suffered some similar injury a second time, and the symptoms have become aggravated again. Perhaps the mere mechanical effect of his work has kept the joint in a continued state of irritation. Eventually he comes to the hospital complaining of pain, tenderness, and weakness of his wrist. Examination shows that the fingers have their normal flexibility, but that the active

and passive motions of the wrist-joint are limited to one-half or less of their normal arc of excursion. Attempts to continue passive motion beyond a certain point, especially in extension, are limited by a most characteristic muscle spasm very similar to that seen in tubercular joints. If the spasm is overcome by force and the wrist moved still further, the pain is intolerable. There is no crepitus or ecchymosis, but there is seen to be slight swelling or thickening over the radial half of the wrist-joint. The outlines of the extensor tendons of the thumb are made less distinct by the swelling, and pressure elicits signs of tenderness definitely localized over the scaphoid bone, and especially in the anatomical snuff-box. The X-ray shows a transverse fracture in the scaphoid.

As compared with the other wrist, a certain amount of alteration of the bony landmarks is found. The relation of the ulna and radial styloids is, of course, normal; but when the wrist is flexed, the prominence formed by the scaphoid just below the lower end of the radius is more pronounced than that of the other wrist and feels quite differently. This difference is, however, not striking enough to form the basis for a diagnosis unless taken with other symptoms. Treatment with counterirritants, massage, rest, forced motions under anæsthetics, etc., fail to bring about any considerable improvement in the condition, and the function of the wrist remains permanently though not greatly impaired.

In order to consider these symptoms more in detail, we have made an analysis of the accompanying eighteen cases which form the basis for the following observations.

Of the eighteen cases, the ages were as follows:

2 cases, 18 years.	1 case, 30 years.	2 cases, 39 years.
1 case, 19 years.	1 case, 31 years.	1 case, 40 years.
1 case, 20 years.	1 case, 32 years.	1 case, 41 years.
1 case, 25 years.	3 cases, 33 years.	1 case, 49 years.
1 case, 27 years.	1 case, 34 years.	

Not only all these cases, but all the others which we have seen, were in males of about the same ages. In thirteen of the eighteen cases the injury was to the right wrist.

Most of the patients were artisans in various trades involving more or less active work, the following occupations being represented: boiler-maker, electrician, shoemaker, cigar-maker, laborer, waiter, two clerks, machinist, electrotyper, hostler, railroad employé, artesian-well driller, dentist, two surgeons, yacht rigger, and student. With a few exceptions, all of the accidents occurred while these individuals were engaged in some athletic exercise, or the injuries were due to some accident not necessarily connected with their trade. In two instances only the injury was caused by direct violence, viz., in Case I, a kick in the wrist; in Case VIII, a marble slab fell on the wrist. In the other instances the injury was due to indirect violence or unknown causes, viz., in Case III, a fall from a bicycle; in Cases V and XV, in playing foot-ball; in Cases VI, X, XII, XIV, XVI, and XVII, from falls varying from one to twelve feet. In only eight cases were we able to obtain a history as to whether the injury occurred in extension or flexion of the wrist; in five of these it occurred in extension;* in the other three, viz., Cases VI, XIII, and XVIII, the patients *thought* that it occurred in flexion, although they were not certain. In every case the pain was at first intense and followed immediately by swelling and excessive tenderness. In nearly every case, the exceptions being those in which the X-ray was taken, the immediate diagnosis of the physician in attendance was "sprain."

Several cases did not consult a physician at all after the first injury, and only came under observation after the lapse of time had failed to relieve their pain and tenderness. In only three cases was there a continued fixation of the wrist in splints for more than a week; these were Cases VI, X, and XIII, which were the only cases which resulted in union. This fact is very important as emphasizing the tendency of active and

* If the reader will examine the extended wrist of a skeleton, he will see that a force exerted in the direct line of the axis of the radius must be transmitted through the scaphoid. Blau has pointed out that such a force will tend to break the scaphoid at its weakest portion, *i.e.*, the neck, which by such force is brought to bear against the styloid of the radius.

passive motions to prevent union, because in all the other cases in which fixation was not maintained union did not occur. Many of the cases complained of secondary injuries which had brought on much the same symptoms as those suffered at the original injury. Cases I, III, V, VII, VIII, XI, XII, and XV are instances of this.

In the majority of the cases the fracture had occurred at almost exactly the middle of the scaphoid, but in five cases, viz., IX, XIV, XV, XVI, and XVII, it occurred at the junction of the middle and proximal third. We are not able to say whether this form of fracture is more or less serious than that of the transverse fracture at the middle of the bone. In either case there seems to be very little tendency towards displacement. In both of the operated cases the displacement was barely perceptible.

As a rule, the patients complain that the forms of motion which cause pain are those which involve pushing with the extended hand or twisting, *e.g.*, opening heavy doors, turning door-knobs, rising from a chair and using the extended hand on the arms of the chair to help in lifting the weight, rowing, playing games, as foot-ball or tennis, fooling with other men, unexpected twists of the wrist, etc. The disability may seriously interfere with the patient's work; for instance, J. G., Case I, is a boiler-maker,—the wrist bothers him most of the time; Case II is a shoemaker,—he is continually troubled with it; Case III is an electrician,—he finds it very inconvenient in using a screw-driver and in writing; Case XIV is a dentist, —he finds his wrist extremely painful in grasping his instruments, especially in pulling teeth.

The tenderness in all the cases was very characteristic, being definitely localized in the scaphoid bone itself, and being especially acute in the anatomical snuff-box. If, in an uninjured adducted hand, the thumb of the examiner be pressed just below the styloid process of the radius in the anatomical snuff-box, the patient will feel an acute tenderness from the pressure on a branch of the radial nerve against the scaphoid bone. This "normal tenderness" is, however, bearable even

if great pressure is made. On the other hand, if the scaphoid is broken, even if the injury occurred many years before, the tenderness in the snuff-box will be too great to be borne without wincing, and the patient will usually try to withdraw his hand. As a matter of fact, when the wrist is adducted and pressure made in the snuff-box, the point touched is almost exactly the middle third of the bone where the fracture occurs. Although the tenderness is most marked in the anatomical snuff-box, there is often found in old cases tenderness over the dorsal portion of the scaphoid. Tenderness in this region is, however, much less acute, and is scarcely more noticeable than in the other portions of the wrist. In a number of cases tenderness over the unciform bone has also been noticed. We have been unable to account for this. Curiously enough the scaphoid tubercle does not seem to be at all tender, and even when firm pressure is made on the tubercle, no pain is caused. This is probably due to the fact that the tubercle is so firmly held by its ligamentous attachments that the position is not changed by pressure.

The swelling in both acute and old cases is in very much the same distribution as the tenderness, being more distinct on the radial half of the wrist and especially about the tendons bounding the snuff-box. There is usually no great swelling, but on comparison with the other wrist there is no difficulty in seeing it. Immediately after the injury there is usually a great deal of swelling of the wrist and dorsum of the hand, so that the diagnosis may be found more difficult than in old cases where the tenderness and swelling are more definitely localized in the scaphoid region. *In no case have we found crepitus or ecchymosis,* although in a few cases the patients themselves have said that the wrist was black and blue soon after the injury. Since very few of the cases have come to us at this stage, we are unable to speak very positively on this point. Most of our cases have come after some secondary injury, the original fracture having occurred some years before. In no case do we recall giving a patient ether and manipulating the wrist forcibly in order to obtain crepitus.

We have been satisfied with the clinical and X-ray diagnosis, and have not thought it necessary to use ether. We are inclined to think that crepitus and ecchymosis seldom, if ever, occur in simple fracture of the scaphoid. The reason for the absence of ecchymosis is that what bleeding there is from the broken bone must go directly into the joint, the capsule of which would not let it escape, thus preventing extravasation of blood from appearing under the skin. The absence of crepitus is due to the accurate fitting of the bones of the wrist, which permits only the slightest possible degree of motion of the fragments. This was beautifully demonstrated in our two operations, where on manipulating the wrist only a very slight play of the fragments was observed.

DIAGNOSIS OF SIMPLE FRACTURE OF THE SCAPHOID.

The consideration of the eighteen cases which we present shows that in the majority the first diagnosis in these injuries has been that of an ordinary sprain, and in the few instances where the diagnosis was at once made, it was confirmed by the skiagraph. We, however, feel that in many of these cases the diagnosis could have been quite positively made on the clinical symptoms; in fact, we have in a few cases made the diagnosis positively before our skiagraph was taken. It must be admitted, however, that in other cases we have been in doubt. For instance, in the following case:

P. F., aged seventeen years; school-girl. This patient, while bowling at cricket in the spring of 1902, in England, felt something snap in her wrist. There was immediate and intense pain and inability to move the fingers or wrist. There was local tenderness and swelling in the region of the scaphoid, and all attempts at motion were very painful. She saw a physician at once, who diagnosed it a sprain, and put her wrist on a splint, and put the arm in a Velpeau bandage with the arm and splint lying across the chest. The wrist was kept in this position for six weeks, and when the splint was removed she could scarcely move her fingers at all. Under massage and similar treatment she slowly recovered the use of her fingers, but the wrist has never been entirely well since.

Six or seven times in the past two years she has injured it less severely, and each time it has been accompanied with intense pain. Six weeks ago, while getting off an electric car, she injured it again, not by falling, but by twisting it as she held the railing in getting off the car.

Examination on May 12, 1904, showed the faintest possible swelling in the region of the scaphoid and marked tenderness over the whole region, particularly in the snuff-box. When her wrist was flexed there was a difference in the contour of the bony landmarks. She could flex the wrist about three-quarters the normal arc and extend it a little over half. Adduction and abduction were about four-fifths the normal. She said that it interfered in writing, in practising her music, and almost everything that she did with her hand. The X-ray showed no definite indication of any injury to the scaphoid.

In this case the clinical history and examination tally very well with fracture of the scaphoid, but the X-ray showed no indication of it. Since, however, the X-ray was not taken until two years after the injury, and at the time of the injury the wrist was kept for a long period in fixation, it is possible that fracture did occur and union took place as in Cases VI and VII. Although union may have taken place, some little distortion of the scaphoid bone may have remained, causing imperfect function of the wrist-joint and the pain of which this young woman complained.

In our experience, cases of sprained wrists, which have been shown by the X-ray to have no fracture, have recovered promptly, that is, within a few weeks; therefore, in the diagnosis from sprain, besides the local tenderness, extensor spasm, etc., we may say that the persistence of the symptoms speaks strongly for fracture of the scaphoid. We cannot feel sure, however, that some cases of fracture do not occur in the scaphoid which run a more favorable course and are soon followed by union and complete restoration of function. From our experience, however, we feel that non-union and disability, as a rule, result.

Besides simple sprain of the wrist, there have been other

cases in which a fracture or fissure in the lower end of the radius have made us suspect fracture of the scaphoid. In these cases, however, careful palpation will almost invariably show that the maximum point of tenderness is on the lower end of the radius and not on the scaphoid. Another point which may assist in this diagnosis is a fact which one of us (E. A. C.) has called attention to in a previous publication, *i.e.*, the sudden appearance of fluctuation in the common bursa or sheath of the tendons of the extensor carpi radialis brevior and longior and extensor secundi internodii pollicis. As this bursa has for its base the periosteum on the posterior part of the lower end of the radius, a crack, either longitudinal or transverse, in this portion of the radius is apt to rupture the base of the bursa, and bleeding takes place into the bursa without appearing as ecchymosis in other parts of the wrist. The result is a tense, fluctuating swelling of rather triangular shape overlying the radial half of the wrist-joint, and extending somewhat up on the lower end of the radius on its dorsal aspect. Since the bursa is thick-walled, the color of the blood does not show through. We have come to regard the presence of this engorged bursa immediately after an injury to the wrist as diagnostic of a fracture or fissure of the lower end of the radius. It is most common in Colles fracture, but may also merely represent a fissure in which there is no displacement of the fragments. In a complete Colles fracture it is sometimes so badly torn that the blood escapes from it, and hence it does not appear fluctuant. Curiously enough, although the presence of this engorged bursa does not speak for fracture of the scaphoid, it nevertheless anatomically overlies the scaphoid region, and pressure over it causes pain which may be mistaken for pain due to pressure on the scaphoid. We have occasionally also seen this phenomenon in the bursa of the extensor metacarpi pollicis and primi internodii pollicis which form the other boundary of the snuff-box. In making the diagnosis of fracture of the scaphoid as distinct from Colles fracture, one must not forget that both lesions may exist at the same time. We have seen a number of instances of this.

In fracture of the scaphoid the relations of the styloids are normal. We have also seen cases which have been complicated by fracture of the base of the metacarpal of the thumb.

In the cases which present themselves long after the injury, confusion with the different forms of arthritis is apt to arise in making the diagnosis. In fact, in such cases the natural diagnosis, unless the history of the injury was definitely recounted by the patient, would be osteoid arthritis. Against this diagnosis, however, we usually find that the patient is rather young, and that his other joints show no evidence of this disease. A careful questioning will bring out the history of a definite injury. Then, too, examination invariably shows the characteristic tenderness in the snuff-box and spasm in forced extension of the wrist. In two cases we recall confusing the lesion with tuberculosis of the wrist; but the absence of the history of the injury and the presence of the local heat, the character of the spasm, and, finally, the location of the tubercular focus by the X-ray, served to make the diagnosis.

In certain cases of inflammatory bursitis of the carpal tendon sheaths confusion might also arise, as these sheaths, as we have said in speaking of hæmorrhage in them, overlie the region of the scaphoid. In such cases, however, the history points to over-use rather than to any injury to the wrist. The location of the tenderness along the courses of the sheaths themselves, rather than deep in on the bone, and the presence of the characteristic crepitus of tenosynovitis suffice to differentiate this lesion.

THE USE OF THE X-RAY IN DIAGNOSIS.

Owing to the peculiar shape of the scaphoid and to the obliquity of the angle with which its long axis lies in relation to the bones of the arm and hand, the appearance it gives in the X-ray is extremely apt to be deceptive. The diagnosis made on the X-ray alone should be made with the utmost caution, and only considered positive when a good view of the bone at right angles to its long axis is obtained.

The scaphoid is shaped roughly like a peanut, and lies, when the hand is laid prone upon a photographic plate, with its long axis at an angle of about 45° with the sagittal, vertical, and horizontal plane. Therefore, to obtain a skiagraph of the scaphoid which shall not be distorted, the tube should be in front, above and to the inner side of the wrist. Even when this precaution is taken, there will still be a slight distortion, because the proximal end of the scaphoid is at a greater distance from the plate than the distal end. The result of this will make the shadow of the proximal end larger than that of the distal end. This latter distortion may be obviated to a certain extent by adducting the wrist. This extends the scaphoid bone, that is, it lifts the distal end so that it comes nearer the plane of the proximal end. In abduction, however, the obliquity is increased and the long axis of the bone stands much more nearly vertical to the plane of the plate. The effect of taking a skiagraph in this position is to throw the shadow of one-half of the peanut so that it overlaps the other half. Since the neck between the two halves does not show, this will give the appearance of two separate pieces, one lying over the other.

If the reader will hold between his thumb and forefinger an ordinary peanut and look at it laterally, so that he can see the long axis at its maximum, he will see the best position in which to take a skiagraph of the scaphoid. If he then rotates the peanut so that its long axis becomes more and more oblique until it is vertical and points directly towards his eye, he will be able to see that the skiagraph will throw the shadows of the two halves of the peanut as separate objects if taken from this point of view.

A practical way to obtain a good picture of the scaphoid is to place the two wrists of the patient in adduction, and to place the tube in a position over the midline between the two hands, as far forward as the level of the knuckles.

Another point which it is well to bear in mind in making the diagnosis of fracture of the scaphoid is the existence of two more or less prominent bony ridges on the neck of the

scaphoid bone which bound the edges of the articular surfaces. These ridges in some cases are very prominent, and as the neck of bone between these two ridges is the thinnest portion of the bone, it is apt to give the appearance of a fracture, unless the X-ray is good enough to show the detail definitely. If the X-ray picture is taken correctly, and a good view of the bone in its long axis obtained, a positive diagnosis can readily be made, for not only can the line of fracture be seen, but often the exact region of the interruption to the trabecular structure of the bone.

It is often very difficult to determine the exact obliquity of the plane of the fracture. This can only be determined by taking a skiagraph which will pass directly through the line of fracture and show an interval between the fragments where there is no overlapping of the two portions. In the two cases in which we operated, we unfortunately did not make a special effort to determine this, and the X-rays taken before operation merely showed that there was a line of fracture and that the two fragments overlapped. At the operation the cleavage was found to run in such a direction that on looking into the wound, after removal of the proximal fragment, the raw surface of the distal portion formed the bottom of the cavity and faced the median line of the dorsum of the wrist. To make the diagnosis positive, one should always take more than one, better three or four skiagraphs from different angles so as to catch the exact plane of the fracture if possible.

From the X-ray appearance we may also form an approximate idea of the time since the fracture has taken place; at least, we may tell whether it has occurred within a few weeks or took place months or years previously. One seldom sees any effort at callus formation, but occasionally this does take place. In Case IV we have a series of X-rays which show a slight callus formation which has increased in amount at intervals of many months. As a rule, the secondary joint changes in other portions of the wrist are more obvious than callus formation of the fracture itself, and one may see on the adjacent surface of the radius and carpal bones little osteophites or liplike formations at the edges of the articular sur-

faces. These do not form until some months or years after the fracture has occurred, and represent the reaction to the mechanical irritation of the displaced fragments. This condition is more pronounced in individuals who are obliged to use their wrists a great deal in their occupations. It has the same general appearance as osteoid arthritis. (I recall making the diagnosis of osteoid arthritis in one of my early cases of fracture of the scaphoid (Case III), and only after the careful examination of the plate in preparing this paper did I see my mistake.—E. A. C.)

Another point which may speak for the existence of an old fracture is a distinct atrophy of the proximal fragment. In several of our skiagraphs of old cases this atrophy of the proximal fragment is noticeable. It probably represents diminished blood-supply, owing to the fact that the main nutrient artery of the bone enters the distal fragment. In some of the older cases, also, there is a distinct change in the appearance of the line of fracture. It becomes more smooth and resembles more closely a normal articular surface. The edges of this false joint are often marked by two dark lines in the skiagraph which represent an increase of density of the superficial layers of the fractured surfaces of the bone. This appearance is very beautifully shown in Case IX. At the edges of such fractured surfaces there sometimes form the secondary osteophites spoken of as existing on the articular edges of the radius and other carpal bones. In cases where the original injury was of a very severe character, and perhaps the other carpal bones were injured too, as in cases of dislocation of the semilunar with fractured scaphoid, these joint changes have gone on to such a degree that the original outlines of the bones are scarcely recognizable. This is illustrated in Case XIII. Such old misshapen joints may be readily confused with the results of rheumatoid or osteoid arthritis.

TREATMENT OF FRACTURE OF THE SCAPHOID.

It is obvious that treatment of fracture of the scaphoid must be considered according to the time after the injury when the patient comes under observation.

If the patient is seen immediately after the injury, we believe it is possible, by fixation of the joint for a proper period, to obtain union between the fragments. If, however, the wrist is not fixed during the first three weeks after the injury, our observations would tend to show that union does not occur and the fracture remains permanently ununited. We believe that if the fracture does remain ununited, the permanent disability is so great that it seriously interferes not only with the comfort of the patient, but with his ability to enjoy certain games and sports, and also in the case of working-men it limits their working capacity, and hence their ability to earn their living.

In our series of cases there are only three in which the wrist was kept on splints continuously for more than a week after the injury. These cases were VI, VII, XIII. In all three cases union has apparently occurred, as shown by the X-ray taken a year later. In spite of union having occurred in these three cases, however, the final result does not show much improvement as compared with other cases where the fracture has remained ununited. Two of these patients complain of a great deal of pain and tenderness, and the third has still slight impairment of the functions of the joint. It so happened, however, that in one case (Case VI), that of a colored man, there was a medicolegal question which at the writing of this paper had only just come to court; and it is not unlikely that this fact may account for a portion of the man's disability at present. The second case is a machinist, and his occupation obliges him to continually turn and twist the wrist in a way which would tend to irritate it and cause what little soreness there is.

In spite of the poor results in these three cases, however, we believe that these individual patients were not especially favorable subjects, and that in recent fractures we should endeavor by fixation for a number of weeks to obtain union before resorting to excision. At just what time after the injury effort to obtain union by fixation should be abandoned is a very delicate question. We should answer this by saying

that after a fixation of four weeks we should resort to massage, etc., for another four weeks, and if at the end of this time there was no encouraging improvement in function, and the X-ray showed no sign of union, we should advise operation. We do not believe fixation would be worth attempting at all after the eighth week, if, in the meantime, the patient had been using his wrist.

Since, in nearly all of the cases which we have followed, the patients have asserted that no help was received from any of the ordinary treatments of sprain, even when we have recommended those treatments ourselves, we feel that such applications are merely a waste of time, and that when we have decided that an attempt to obtain union by fixation is useless, we should at once recommend excision of one-half or both halves of the bone. Apart from the hopelessness of obtaining union, we find that excision of the bone is indicated to relieve the mechanical irritation caused by the slipping of the fragments on one another, which sets up a chronic synovitis and leads to more or less secondary change in the joint. Thus the joint, instead of improving with use, tends to get worse rather than better, and is ever becoming more subject to renewed injuries and the stiffening effects of chronic arthritis.

When the case is seen many years after the injury, the question is presented in a still different point of view; for instance, Case XV, a personal friend and a surgeon, had broken his scaphoid bone ten years previously in playing football, and since that time had had repeated injuries. This individual had become more or less used to the tenderness and lack of suppleness in his wrist, and since he had become accustomed to it for so many years, the question of excision seems to have a different bearing. In his case, however, because he is fond of athletics, and because the soreness troubles him in his surgical work, we are inclined to advise excision of the bone; although we should hesitate to urge the operation on the ground that a certain amount of compensatory arthritis has already taken place, and even though the source of irritation is removed, the expected result cannot be so good as in a

more recent case in which no secondary joint changes have taken place. On the other hand, in the case of another personal friend, also a surgeon, who had suffered the same injury only three months before, we did advise excision of the fragment on the ground that no secondary changes had taken place, and that we might expect the tenderness, pain, and spasm to be relieved when the source of irritation was removed. The result so far has justified our expectations, and within six weeks after the operation the patient asserted that the wrist was already better than before it was operated on. In the only other case in which we were able to obtain the consent of the patient for operation (Case XVII), the result has been equally satisfactory, although the injury had occurred six months before the operation.

The experience of the other cases which have not had operative treatment has been almost negative; even rest and massage only producing slight temporary benefit, excepting in the acute stage, where the immediate pain and tenderness are certainly helped by the application of a splint. Liniments and counterirritants appear to have no effect.

We have regarded any mechanical method of stimulating callus formation between the fragments as much more dangerous to the wrist-joint than excision, particularly as the three cases, in which we have observed that union has occurred, more or less disability has still remained.

We believe that if operation is refused, the wisest treatment is to merely guard against further injury, and by limiting the use of the joint to endeavor to avoid a chronic arthritis. Many patients have felt relief by wearing a leather wristlet, but this has produced no essential improvement.

The operation for removal of the proximal fragment of the scaphoid bone which we have devised is quite simple and easy of execution either under cocaine or ether. An incision one-half inch long is made on the dorsum of the wrist just to the inner side and parallel to the border of the extensor carpi radialis longior tendon. The skin wound is held apart with retractors, and an incision of about the same length in

the same line made through the annular ligament in the fibrous septum between the long extensors of the fingers and the long extensors of the wrist. This may be done without opening the bursæ surrounding any of these tendons. It will be found that the annular ligament does not gape when the wound is made, so that the incision in the ligament has to be held apart with retractors. Even if the bursæ are opened, as in one of our cases, there is apparently no harmful result. This incision directly exposes the wrist-joint over the proximal half of the scaphoid bone, and if the wrist be abducted, nearly the whole of the scaphoid bone can be brought across the incision. The line of fracture is found on the articular surface towards the radius and a blunt hook introduced into the fissure. In Case XVI, our first case, this line was difficult to find because the cartilaginous surface was broken across obliquely so as to produce bevelled edges which overlapped. With a tenotome the ligaments connecting the posterior portion of the proximal fragment with the capsule of the wrist-joint and with the semilunar are divided. When these have been divided, the fragment still does not move greatly from its position, so that it is necessary to pull firmly upward with a tenaculum through the wound and flex the wrist in order to divide with the tenotome the anterior ligamentous attachments. In both of our cases little flakes of bone were torn from the anterior face of the fragment by the ligamentous attachment and had to be removed after removing the main portion. We found that the distal portion of the scaphoid remains firmly attached to the surrounding ligaments and appears to be capable of taking up the functions of the whole bone.

The wound may or may not be closed. It will be found that the incision through the posterior part of the capsule and annular ligament has no tendency to remain apart, and a stitch in it seems unnecessary. In our first case this was drawn together lightly with one catgut suture and the skin wound left open. The patient had a great deal of pain the first night from distention of the wrist with fluid, whereas in the second case, where we purposely did not close the ligament, there

was practically no pain. In both cases the skin wound was closed by a single subcutaneous suture, which was not pulled tight until the following day in order to let the discharge of serum relieve the tension of the joint, and thus avoid pain.

We advise beginning very slight passive motion within a week in order to prevent adhesions, and at the end of two weeks entire removal of the splints and both active and passive motion of the joint permitted. The use of the fingers may be allowed at the end of a week.

The only unpleasant symptoms which have followed in either of these operations have been in the first case,—a slight irritation of the wound due to a rather excessive discharge of synovial fluid from the joint, and in both cases adhesion of the skin wound to the wound in the ligaments. This has produced a puckering of the skin of the wrist in extension which is somewhat unsightly, although not painful. This, of course, could be easily remedied by removing the scar in the skin and resuturing, but in the next case we should prefer to make the skin incision transverse and the incision in the ligament vertical.

We feel, from the study above presented, that the following conclusions as to the treatment of simple fracture of the scaphoid are justified:

I. Cases which have not been treated or which have been treated as sprains, by a short period of fixation followed by massage, active and passive motion, etc., seldom, if ever, have union of the fragments.

II. If the joint is kept fixed for a number of weeks immediately after the injury, union may occur, but the functional result is not perfect, although better than in cases of non-union.

III. It is too late to obtain union if fixation is not attempted within a few weeks after the injury.

IV. Excision of the proximal half of the broken scaphoid promises a better ultimate result than any other form of treatment.

V. Since operation, nevertheless, is an undesirable risk, a reasonable attempt should be made to obtain union by fixation, if the case is seen soon after the injury.

VI. Operation should not be delayed many months, because secondary joint changes may occur and chronic arthritis result.

VII. The advisability of operation in cases of long standing is doubtful, and must be decided by the amount of disability present in each individual case.

CASES OF SIMPLE FRACTURE OF THE SCAPHOID.

CASE I.—J. G.; boiler-maker; aged thirty-two years; male. This patient was injured in a street fight, July 6, 1897. Among other injuries, he was kicked in the left wrist by one of his assailants. He came to the Out-Patient Department of the Massachusetts General Hospital the next day. There was considerable swelling over the wrist and some tenderness, but no apparent fracture. He was not examined by the X-ray. A diagnosis of sprain was made, and splints and bandages applied, and he was told to return in a week. He did not return, but removed the splints in a week and went to work. He came to the hospital again in December, 1897, complaining that the wrist had troubled him ever since the injury when he did hard work, and, as he is a boiler-maker, this means most of the time. At this time there was no swelling or deformity; flexion and lateral motion were noted as perfect, but extension was limited about one-half. He said the wrist was stiff when he began work in the morning. The X-ray showed a fracture of the scaphoid bone in its middle third.

CASE II.—M. H.; shoemaker; aged twenty-seven years; male. This patient came to the Massachusetts General Hospital, March 24, 1899. He said that for four years he had had pain in his right thumb and weakness in his wrist. The pain went away with rest, but came on again when he worked. For four days before he came to the hospital there had been a swelling on the back of the hand. Passive motion was interfered with by stiffness of the joint, and there was local swelling at the base of the thumb. There was no numbness or motor weakness. He gave no history of having had an injury, but the X-ray showed a fracture of the scaphoid bone, with some old injury of the lower end of the radius as well.*

CASE III.—N. W. J. H.; electrician; aged thirty-three

* For the notes on this case and Case I we are indebted to Dr. F. G. Balch, although Case I was seen by E. A. C.

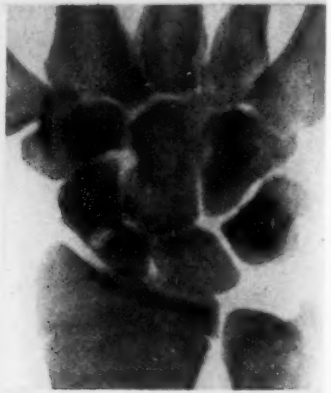
CASE 5. (a)
DEC. 11. 1901. (ant.)

CASE 5. (b)
JAN. 25. 1902. (post.)

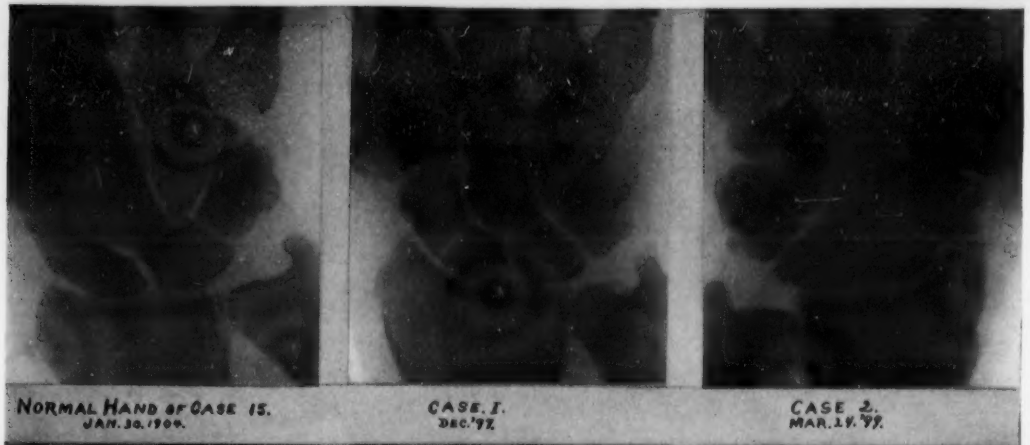
CASE 5. (c)
MAR. 26. 1904. (ant.)

CASE 6. (a)
MAY 14. 1901.

CASE 6. (b)
NOV. 1904.



CASE. 7.
MAY. 8. 1902.



NORMAL HAND OF CASE 15.
JAN. 30. 1904.

CASE. I.
DEC. '97.

CASE 2.
MAR. 24. '99.

CASE 3.
MAR. 15. 1901.

CASE. 4. (a.)
MAR. 22. 1901. (ant.)

CASE 4. (b.)
APR. 15. 1904. (lat.)

years; male. This patient first injured his right wrist by falling from a high bicycle on his extended hand in the summer of 1895. He does not remember that he received any treatment for it. The wrist remained lame and troublesome, and in March, 1901, he again hurt it while stretching a wire in doing some electrical work. At this time he was using a screw-driver both before and after the injury. He thinks this aggravated his symptoms. About this time he came to the hospital under my care, and was treated by the application of a leather and, later, a steel splint. My diagnosis at this time was an arthritis of the joint between the trapezoid and scaphoid, and, in spite of the fact that at this time I had already seen a number of X-rays of fractures of the scaphoid, I did not make a positive diagnosis. It was only recently, on looking over his plate with other X-ray plates, that I felt confident of the diagnosis. (E. A. C.) The patient, by letter, on April 17, 1904, says that the wrist still troubles him, especially in such motions as using a screw-driver and using pen and ink. He says that now there is no swelling or tenderness "exteriorly;" that it aches and feels sore internally after a few hours' work, and in much less time if the work is heavy. He cannot write legibly if he tries to write quickly, and the wrist is much less useful for "every purpose."

The X-ray taken on the 15th of March, 1901, shows an old fracture of the scaphoid bone, with an overlapping of the fragments and a decided amount of secondary bony change in the region adjacent to the trapezoid. The X-ray also suggests that there was a third small fragment as well as the two large ones. The fracture occurred at the middle of the bone. Unfortunately, the only skiagraph we have was taken in the straight position instead of in adduction.

Case IV.—A. D.; teamster; aged thirty-nine years; male. This patient presented himself at the Massachusetts General Hospital on the 22d of March, 1901. About an hour before, his thumb had been injured by having a truck roll over it. An X-ray taken at the time showed an oblique fracture of the proximal phalanx of the thumb of the right hand, and incidentally a fracture of the scaphoid bone; but since there was a considerable deformity of the adjacent portion of the radius, it was evident that the fracture of the scaphoid had occurred some years before. The patient could remember no injury to his wrist previously. The

fracture of the thumb was set and convalescence was uninterrupted. He returned for examination on April 5, 1904. The bony landmarks in the neighborhood of the scaphoid were much altered from their normal relation, and his power of flexion, extension, and abduction were slightly limited; adduction was normal. He stated that the wrist did not interfere at all with his work.

The X-ray taken on the 22d of March, 1901, shows a fracture of the scaphoid at the junction of the middle and proximal third. The shadow of the distal fragment is distinctly more dense than that of the proximal fragment. The line of separation of the two fragments is not clear. The plane from which the X-ray was taken suggests that the fragments overlap, so that the rays did not come directly through the gap between them. There is a distinct secondary alteration of the line of the lower end of the radius in the portions which come in contact with the deformed scaphoid.

The X-ray taken on April 5, 1904, shows much the same condition as that taken in 1901, except that the scaphoid appears to have partially united; although this appearance may be due to the overlapping of the fragments. The scaphoid of the other side shows no indications of a weakened area in the region where the other is broken. We cannot assert positively that this was not a case of bipartite scaphoid, but the presence of arthritic changes indicates very strongly that it was a traumatic condition.

Case V.—H. S. F.; student; aged nineteen years; male. In the latter part of October, 1901, this patient "sprained" his left wrist in playing foot-ball. Three days later he sprained it much more severely. There was great pain and swelling and tenderness over the wrist-joint. All motions were painful. The surgeon of the foot-ball squad considered it a sprain, and the wrist was kept on a splint for about a week, after which the patient was allowed to use his hand. Although there was some improvement in motion, the tenderness and swelling still continued, and about two months later the patient consulted me at my office.

At the time I saw him there was decided swelling over the radial half of the wrist-joint, great tenderness over the scaphoid bone, particularly when pressure was made in the anatomical snuff-box with the wrist adducted. There was marked spasm

in extension, so that the wrist could only be extended for 10° or 15° without giving great pain. I made a diagnosis of fracture of the scaphoid and confirmed it with the X-ray. As two months had elapsed since the injury and there appeared to be no sign of union, I thought it was probable that the fracture would remain ununited, and, therefore, only kept the patient on splints for two weeks, at the end of which time I began massage. This was continued for several months, but the condition of the wrist was not greatly improved. The disability remained so great that, in consultation with Dr. A. T. Cabot in the spring of 1903, we thought it wise to break up the adhesions under ether so as to allow more free motion. This was accordingly done. When the muscles were relaxed under ether, it was found the wrist could be extended through its normal arc without any great force being used. Twice after this within the ensuing month the wrist was forcibly extended without giving ether, and, though the spasm was very marked, the normal arc of motion could be gone through. The pain, however, was excruciating, and a great deal of swelling and tenderness followed without a proportionate amount of benefit.

At the present date, March 28, 1904, the condition is not greatly different from that when I first saw him two years ago. There is still a fulness in the radial half of the wrist-joint and decided alteration of the bony landmarks; there is acute tenderness in the snuff-box, and any motion which forces the hand backward in extension beyond an angle of about 40° is extremely painful and checked by involuntary spasm. Flexion and adduction are normal, but abduction can only be carried a few degrees from the straight position.

The X-ray in December, 1901, showed a transverse fracture in the middle of the left scaphoid. Several months later, January 28, 1902, there appeared to be a collar of bony callus formed about the seat of fracture, but no union between the fragments. On March 26, 1904, the X-ray shows a still larger bony callus which seems to arise chiefly from the distal fragment.

Case VI.—M. J.; waiter; aged thirty-three years; male; colored. On May 13, 1901, this patient fell from a staging on his flexed right hand. He went to a doctor at once, and was told that he had "sprained" the wrist. The next day he came to the Massachusetts General Hospital, Out-Patient Department, where an X-ray was taken showing fracture of the scaphoid, and

he was put on splints for about three weeks and afterwards bandaged and massaged. As far as he can remember, it was under treatment eight weeks.

On February 8, 1904, we examined the patient again. Considerable alteration of the bony landmarks was found, and there was no local swelling, but decided tenderness. He had about one-half of the normal extension of the wrist-joint and slight limitation in flexion; abduction and adduction were normal. He said that it interfered with his work a great deal; that he could not carry heavy weights in that hand; that he could not press forward very hard, as in opening a heavy door. Extreme motions in all directions caused pain in the region of the scaphoid. He thinks the wrist is a little better than it was a year ago. Since this patient was suing for damages for this injury, we feel that he may have somewhat exaggerated the amount of disability.

The X-ray at the time of the original injury showed a fracture exactly in the middle of the right scaphoid, and a small fragment on the radial side of the bone in addition to the two main fragments.

The X-ray in November, 1904, shows that union of the bone has taken place, but there is considerable change in the normal outline. The middle fragment on the radial side has formed a small protuberance.

Case VII.—J. C.; electrotyper; aged eighteen years; male. In November, 1901, J. C. "hurt" his left wrist in playing football, and again "injured" it from a fall from a bicycle May 7, 1902. He regarded the injury as a sprain on both occasions, and did not consult a doctor until May 10, 1902. He wore a wrist-strap after the first injury, but no splint was applied. On May 10, 1902, he came to the Massachusetts General Hospital, Out-Patient Department, under my care. He was kept on splints for four or five weeks, and then massage was used for a short time afterwards. At the time I saw him the symptoms and signs were characteristic of fracture of the scaphoid, *i.e.*, localized swelling, tenderness, spasm in extension, all motions somewhat painful, particularly if forced beyond the degree in which involuntary spasm began. There was no ecchymosis. The patient said that at the time of both injuries the pain had been extreme. The treatment in this case seemed to be quite effective, and at the time of discharge the incapacity was not as great as is often seen.

This same patient in July of the same year hurt his right wrist, and possibly suffered the same injury in his right as he did in his left wrist. That of the right was caused by catching a swift base-ball, which forcibly extended his wrist. The injury seemed to him so nearly like the original injury to his left hand, that he made his own diagnosis, and was able to assist his own physician in the treatment, and did not come to the hospital. He kept the wrist on a pasteboard splint for three weeks before beginning to use it, and had no massage after leaving off the splint. Examination of the patient was again made on January 29, 1904. The left wrist was slightly tender, not swollen, and the limitations were only slight. His right wrist was, however, decidedly tender; extension and adduction were limited one-half, and the other motions were considerably more impaired than those of the left. There was slight alteration of the bony landmarks. He says that neither wrist interferes with his work, but that he notices both in unusual exercise, especially when fooling with other men or when playing games.

The X-ray of the left wrist in May, 1902, shows a subluxation of the semilunar and a chip off its posterior edge, as well as a fracture of the scaphoid. It is unfortunate that we are unable to reproduce the X-ray in January, 1904. It showed no sign of fracture of either scaphoid, and it is particularly interesting that in this case the epiphyseal lines in the radius and other bones have united as well as the fractures of the scaphoids. This case, from the fact that he may have had a fracture of both scaphoids, and that the scaphoids have united at the same time when the epiphyseal junction took place, speaks for Professor Dwight's hypothesis.

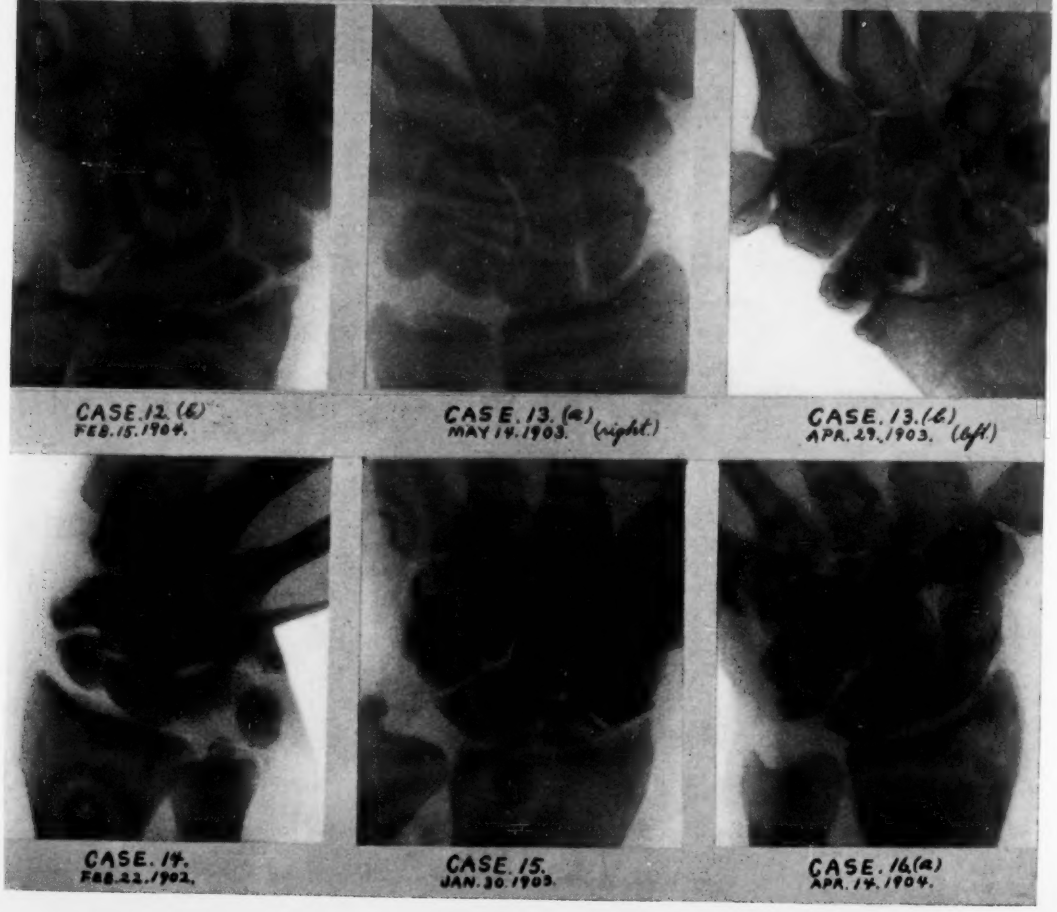
Case VIII.—E. G.; cigar-maker; aged thirty-three years; male. About fourteen years ago, E. G. had a marble slab fall on his left wrist. A day or two later his hand was forcibly extended by indirect violence from a fall (?). He went to the Boston Dispensary and had applications (?) made to the wrist for about a week. Since this time he has had more or less trouble with the joint, and came to the Massachusetts Hospital on the 22d of April, 1902, to see if anything could be done for it. There was localized tenderness and swelling over the scaphoid and pain on extreme flexion or extension of the wrist. There is no record of the treatment that he received at the hospital at that time. I saw the patient again on January 29, 1904, and found that tenderness

over the scaphoid was still present. There was no swelling, but the bony landmarks were considerably altered as compared to the other wrist. Flexion and adduction were normal, but extension and abduction were slightly limited. The patient said it did not interfere with his work, but occasionally hurt when forcibly extended.

The X-ray shows a united fracture of the scaphoid in the middle third. There appears also to have been some compensatory change in the shape of the articular surface of the radius. The condition of the bone in the X-ray of 1904 is practically the same as that seen in 1902.

CASE IX.—P. J. B.; clerk; aged forty years; male. On the 25th of November, 1902, this patient struck a man in the jaw with his closed fist, so that the blow was felt almost entirely on his bent knuckles. He came at once to the hospital. At this time the base of the metacarpal of the right thumb was swollen and tender, and a fracture was diagnosed and confirmed by the X-ray. Incidentally, the X-ray showed an old fracture (?) of the scaphoid at the junction of the middle and proximal third. Owing to the manifest tenderness of the recent fracture of the metacarpal of the thumb, the scaphoid injury was overlooked, and it was not until the following year, in looking over a large number of X-ray plates, that we noticed the scaphoid lesion and sent for the patient.

We examined him on February 10, 1904, with especial reference to the lesion in the wrist; although the fracture of the metacarpal had left a considerable deformity (Smith's fracture). The patient said that he might have injured his wrist years before, but could give no definite history of it. There were still decided swelling and tenderness in the radial half of the wrist-joint, great alteration of the bony landmarks, and all motions of the wrist greatly limited. He said that it did not interfere with him in his work, but did hurt him to row, and it often hurt when he was playing games or fooling with other men. The thickening over the scaphoid was so great as to resemble the fusiform swelling of tuberculosis. The X-ray in this case is very interesting. There appears to have been a fracture at the junction of the middle and proximal third of the scaphoid, following which a secondary deformity of the joint has taken place, and the adjacent bones show the ragged condition so often seen in osteoid arthritis. It is noticeable that the proximal portion of the scaphoid is greatly atrophied as compared to the distal portion, the adjacent edge of which has evi-



CASE. 12. (b)
FEB. 15. 1904.

CASE. 13. (a) (right)
MAY 14. 1903.

CASE. 13. (b)
APR. 29. 1903. (left)

CASE. 14.
FEB. 22. 1902.

CASE. 15.
JAN. 30. 1903.

CASE. 16. (a)
APR. 14. 1904.

CASE. 8.
JAN. 30, 1904.

CASE. 9.
NOV. 25. 1902.

CASE. 10.
JUNE. 27. 1903.

CASE. 11. (a)
APR. 16, 1903.

CASE. 11. (b)
APR. 16. 1903.

CASE. 12. (a).
APR. 13. 1903.

dently formed a new bony layer at the fractured surface as shown by a dark line in the X-ray. The disability in this patient's case was so great as to warrant my advising excision of the scaphoid, but the operation was refused. As in Case IV, we cannot assert positively that this may not be a bipartite scaphoid.

CASE X.—F. E.; machinist; aged forty-one years; male. In February, 1903, F. E. fell off a load of logs and landed with his hand under him, hurting it severely. He states that all motions of the left wrist were very painful. There were local swelling and tenderness over the joint. His doctor treated it with antiphlogistine for two or three weeks, but since the wrist continued sore he came to the Massachusetts Hospital, and it was put in splints for about two weeks. His local doctor had considered it a sprain. The X-ray taken at the hospital showed a fracture of the scaphoid, although not as clearly as it often does, since the fragments were overlapped.

We again examined the patient on February 12, 1904, and found decided localized swelling and tenderness, alteration of the bony landmarks, and limitation of all the motions of the wrist to about one-half the normal amount. He stated that it did not interfere much with his work, but he noticed it every day; he could lift but could not twist with that hand; he could not push open a heavy door, and it constantly became sore after use. The thickening about the scaphoid was so great as to induce us to advise him to have the proximal portion of the scaphoid removed. He was not willing, however. The X-ray taken on June 27, 1903, showed considerable atrophy of all the bones of the wrist and fracture of the scaphoid in its middle third, with overlapping of the fragments and a questionable partial subluxation of the semilunar. The X-ray on the 12th of February, 1904, while not clear as to the point as to whether the fracture has united or not, shows a decided alteration as compared with the other wrist.

CASE XI.—E. C.; hostler; aged twenty-five years; male. In 1900 he fell on his right wrist and sprained it. On April 6, 1903, he was thrown by a horse and fell on the right wrist with the hand extended. He came at once to the hospital, and examination showed local tenderness and swelling over the scaphoid, spasm in extension, and pain in all motions. The X-ray showed a fracture of the scaphoid which was evidently not recent, as the outlines were smoothed off and presented the appearance char-

acteristic of an ununited fracture rather than a fresh fracture. In the lateral view a small fragment, about the size of a No. 6 shot, was seen opposite the posterior edge of the semilunar bone; but it was impossible to tell from which bone this fragment had been torn. The patient was kept on splints for about three weeks. No further record of the progress of his case was kept until January 30, 1904, when he was again examined. There was no swelling or tenderness unless extreme motions were forced. There was decided alteration of the bony landmarks. Flexion and extension limited one-half. There was more or less limitation in adduction and abduction. He said that it did not interfere with his work at all, but the characteristic guarding spasm in extension showed there was decided irritation of the joint.

An X-ray taken on the 4th of April, 1904, shows practically no change from the one taken in the previous year.

Case XII.—E. W. B.; railroad employé; aged thirty-nine years; male. On April 13, 1903, he fell from the top of a freight-car with his right hand doubled up underneath him. He does not know whether his hand was flexed or extended. He came at once to the hospital, and the X-ray showed a transverse fracture of the scaphoid and a Colles fracture. The character of the X-ray of the scaphoid makes it probable that the fracture was an old one and did not occur at this injury. Inquiry later revealed the fact that the cause of the fall from the car was really due to a weakness of the right wrist caused by a fall from a chair three months before. The original injury was supposed to have been a sprain, and he had worn a splint on the wrist for a week, but it had never felt right again. At the time I saw him at the hospital I treated him for the Colles fracture especially, because there appeared to be no especial pain or tenderness over the scaphoid. He was kept on splints, silicates, etc., for about six weeks.

On February 15, 1904, I examined him again. There was no tenderness over the scaphoid, but I found a very slight thickening and a slight deformity over the Colles fracture which obscured the normal relations of the scaphoid. The motions of the joint were only half of the normal, and the patient said that the wrist interfered with his work considerably. Constant strain tired him. He noticed discomfort from it in turning a door-knob or pressing against the wall. The X-ray in April, 1903, shows a typical recent Colles fracture with posterior displacement, a small chip of bone

off the ulnar styloid, and a transverse fracture through the middle of the scaphoid. There are compensatory changes in the adjacent surface of the radius.

In the X-ray of February 15, 1904, the same changes are noticeable, except that the Colles fracture has entirely healed. The scaphoid remains ununited. There is no sign of any interval corresponding to the point of fracture in the opposite scaphoid.

CASE XIII.—W. B.; artesian-well driller; aged forty-nine years; male. On April 21, 1903, while he supposed his machine was shut down for oiling, he had his right hand in the apparatus, which started up unexpectedly and caught his wrist and violently flexed it. Three days later he went to the Massachusetts Hospital, where the wrist was put on splints for five weeks and bandaged for two weeks longer. The X-ray at this time showed a questionable fracture of the scaphoid; there was local tenderness and swelling, especially in extension; slight ecchymosis on the palmar side of the wrist, and all motions were painful.

The patient was examined on February 18, 1904, and the motion of the wrist found to be excellent, except slight limitation in flexion and extension and slight alterations of the bony landmarks. He said that it did not interfere with his work at all.

It so happened that this same patient had injured his left wrist by having it caught in a cable on shipboard fourteen years ago. There exists at present a marked deformity and bony enlargement of the wrist, with more tenderness over the scaphoid than in any other portion. He can work with it without any trouble, but any blow against the left thumb gives him pain in the region of the scaphoid. The wrist is almost stiff, having only a few degrees of flexion. The X-ray in April, 1903, of this case was interpreted at the time positively as showing fracture of the scaphoid. From the X-ray alone in this case I should be unwilling to make a positive diagnosis, but I believe that the lesion in both wrists of this patient was fracture of the scaphoid in its middle third. The X-ray taken in 1904 seemed to indicate that there has been union of the scaphoid in the right wrist.

CASE XIV.—G. T. L.; dentist; aged twenty-eight years; male. This patient was a student in the Medical School at the time I was first interested in fractures of the scaphoid, and a diagnosis was made at that time. My notes on the case were lost, and I again wrote to him in April, 1904. The following letter from Dr. L. gives his own version of the history. "In answer to

your inquiry, I would say that the fracture of the scaphoid bone of my right wrist happened during the fall of 1896. I was at that time a student at Lawrence Academy, and, while performing on the horizontal bar in the gymnasium there, I slipped and fell to the mattress, a distance of seven feet. Falling forward, I extended my hand as if to save myself, and struck with my whole weight on my right hand and extended it backward. I attempted to continue with the performance, but was unable to use the hand. I visited a physician, who diagnosed it as 'a simple fracture' and bandaged it. This was all the treatment that it had. Your attention was called to it while I was attending a clinic at the Female Out-Patient Department, Massachusetts General Hospital. The same condition is present as at the time that you saw it. . . . It causes me the greatest trouble when writing and in extracting teeth, and at times the pain is so severe that I can hardly grasp the forceps. It interferes in any work that requires grasping an object and in pulling, as in extraction of teeth. It soon tires by long use, as in dissecting and writing."

My recollection of the examination of this wrist is that his motions were more free than the usual run of scaphoid cases. He says in his letter that there is no swelling now, but there is "a sort of dislocation, as the fragments slip over one another." I remember that when I saw him at the hospital this snapping of the fragments suggested that one of the tendons was dislocated, so that it snapped in and out of place. I am not sure whether it is really the bone which causes the snapping or one of the tendons.

The X-ray shows an ununited fracture of the scaphoid at the middle and proximal third, with probably a third fragment coming from the middle portion.

Case XV.—H. W. B.; physician; aged thirty-four years; male. In September, 1893, while playing foot-ball, his right wrist was forcibly extended. He consulted a physician within a few hours, and a diagnosis of "sprain" was made, and a leather wristlet was applied, which he wore for about two months. Meanwhile he kept on playing foot-ball in spite of the pain and tenderness. There was marked local swelling in the scaphoid region, spasm in extension, and all motions were painful. The wrist has never been well since, although he has always been able to use it for ordinary work, being occasionally obliged to rest it on account of the swelling, pain, and tenderness. It is subject to injury from any force which suddenly extends the wrist. Within a few

months of the present date, January 30, 1904, there has been one of these exacerbations. There is no distinct swelling and local tenderness over the scaphoid bone, but there is a decided change in the bony landmarks, and all the motions of the joint are slightly limited. There is distinct spasm as the wrist approaches extreme extension. It is, and has been, an annoyance to him in his work, in certain positions hurting more than others, and even at times preventing the use of it for a few moments. Pressure in the snuff-box is intolerable. The X-ray shows a transverse ununited fracture at the junction of the middle and proximal third of the scaphoid. The bony structure of the proximal portions is not as clearly defined as in the distal, and it appears to contain an area about the size of a No. 6 shot in which the trabeculæ are destroyed. There are compensatory changes in the articular surface of the adjacent portions of the radius. The other wrist is normal.

Case XVI.—W. C. S.; physician; aged thirty-one years; male. On January 20, 1904, while in his bath, he fell on his extended right wrist, so that the full weight of his body was thrown onto the palm of his hand. There was extreme pain at once, marked local swelling over the scaphoid, tenderness and spasm in extension, very faint ecchymosis, and all motions were painful. Three hours after the injury the wrist was put upon a mill-board splint and bandaged. The lesion was considered a sprain, so that the splints were worn on and off for a week, being removed at times to allow the use of the wrist. After a couple of weeks, as there was no great improvement, a fracture of the scaphoid was suspected, and the patient examined his wrist with a fluoroscope, but the fracture was not seen. The symptoms continued, and on my examination on March 9 there was still evident swelling in the radial half of the wrist, decided tenderness in the anatomical snuff-box, and a slight change in the bony landmarks as compared with those of the other wrist. Motions were somewhat limited and checked by spasm in extreme positions, and the patient complained of pain and weakness in any motions requiring a moderate amount of force.

On March 15, 1904, the patient writes as follows: "All motions of flexion and extension and adduction are very plainful when forced beyond a certain extent. The whole treatment has been much abused and practically *nil* in my case. The wrist grows gradually but slowly better, and has had no serious setback."

The X-ray shows a transverse fracture of the right scaphoid

at the junction of the middle and lower third, with a moderate amount of displacement of the proximal fragment. The scaphoids of both wrists in this patient are large. The structure of the bone in the left wrist shows no indication of the existence of a bipartite formation. I advised operation, and performed it as follows on April 25, 1904, under cocaine and with the assistance of Dr. Henry M. Chase.

A tourniquet was placed about the upper arm and about three drachms of one-half per cent. solution of cocaine injected on the dorsum of the wrist in the region of the extensor tendons. An incision one-half inch long was made between the common sheath of the radial extensors and the long extensors of the fingers. The incision was carried through the posterior annular ligament directly into the wrist-joint, with its upper end at the edge of the articular surface of the radius. Retraction of the cut edges of the annular ligament exposed the scaphoid bone. When adduction was made, a fine line of fracture was seen transversely across the articular surface of the scaphoid. A blunt hook was introduced into this fissure, and traction on the hook moved the whole bone instead of one fragment, so that it was evident that either partial union had occurred or that the ligaments held the two fragments so closely together that they moved as one piece. No crepitus could be obtained, and the fragments could barely be made to move on one another. The attachment of the proximal portion of the bone to the dorsal ligament was then divided with a tenotome, and also the attachment of the ligament uniting the scaphoid to the semilunar. A blunt instrument was then introduced into the crevice of the fracture and the distal fragment pried out of its bed. In doing this, the fragment was apparently torn in halves. It was impossible to tell whether this fracture was due to the manipulations of extracting the fragment or whether it already existed. When this fragment was removed, another fragment lying to the palmar side was seen still more or less firmly attached to the distal portion of the bone. This fragment, also, was easily pried out of its bed, and freed by a division of some fibrous bands holding it to the anterior portion of the joint. When both fragments had been taken out, the fractured surface of the remaining portion of the scaphoid was in plain view, and presented the appearance of a fresh fracture. There appeared to be no attempt at callus formation either on the fragment that was left in or on the fragment that was taken out,

with the exception of a few granulation-like masses on the surface of the fragment which was removed.

When the tourniquet was removed, there was a great deal of oozing from the wrist-joint, so that it was felt unwise to close the capsule tightly, particularly as the incision in the ligament seemed to fall together naturally of itself and have no tendency to pull apart. A subcutaneous stitch was placed in the skin incision and one catgut stitch in the incision in the ligament. The subcutaneous stitch was not pulled tight, so as to allow free oozing into the dressing, and the arm was put upon a palmar splint extending to the elbow, and a voluminous dressing applied. The patient said that except for the tightness of the tourniquet the operation gave him no pain.

A letter from the patient on April 28 says, "Just a word to let you know that my wrist is now getting along finely. For the first twenty-four hours the pain was very considerable, much more than I supposed it was going to be, so that I took one-half a grain of morphine that night."

June 4, 1904. He wore the full length splint for five days, and then shortened it to the metacarpophalangeal joints and wore it for a week more, after which he wore a bandage for three days, thus after two weeks he wore no apparatus at all on the wrist. The skin wound did not heal by a perfect first intention (but did not become septic), so that there was a slight ooze from it for about two weeks. About the wound there was considerable thickening of the soft parts and some redness, but no discharge of pus. The swelling and redness have gradually subsided, but they are still present to a considerable extent. He has had perfect use of the fingers since removing the splint, and the wrist feels somewhat better than before the operation.

Examination shows that the scar is rather lumped up, red, and irritable looking. The skin scar is adherent to the ligamentous scar, so that when the wrist is extended there is a reduplication of the skin in folds. His adduction and abduction are normal. Flexion within ten degrees of normal and effort at further flexion not painful. Extension is only one-half normal, and forced extension is still painful as in an ordinary scaphoid case. He says that a straight pull or a grasp does not hurt him, but in certain positions of twisting or where leverage is made on the thumb there is decided pain, particularly when his wrist is relaxed and the force unexpected. He has not attempted to play golf or

tennis, as he still feels that the wrist is too weak. It does not bother him, however, in operating.

A letter from the patient on October 11, 1904, says, "In answer to your letter of the 2d inst., I will give the following report. Present condition of wrist.

"*Adduction* complete; slight pain on forcible adduction; slight tenderness on pressure over point of the scaphoid, but less than three months ago.

"*Abduction* slightly limited, and pain on forcible abduction.

"*Flexion* very slightly limited; no pain on forcible flexion, but a pull on the adhesions of the scar.

"*Extension* slightly limited; less so than three months ago; slight pain on forcible extension.

"In other words, ordinary movements of the wrist are free and without pain, almost normally strong in grasp, except where there is too much tax in a position of adduction.

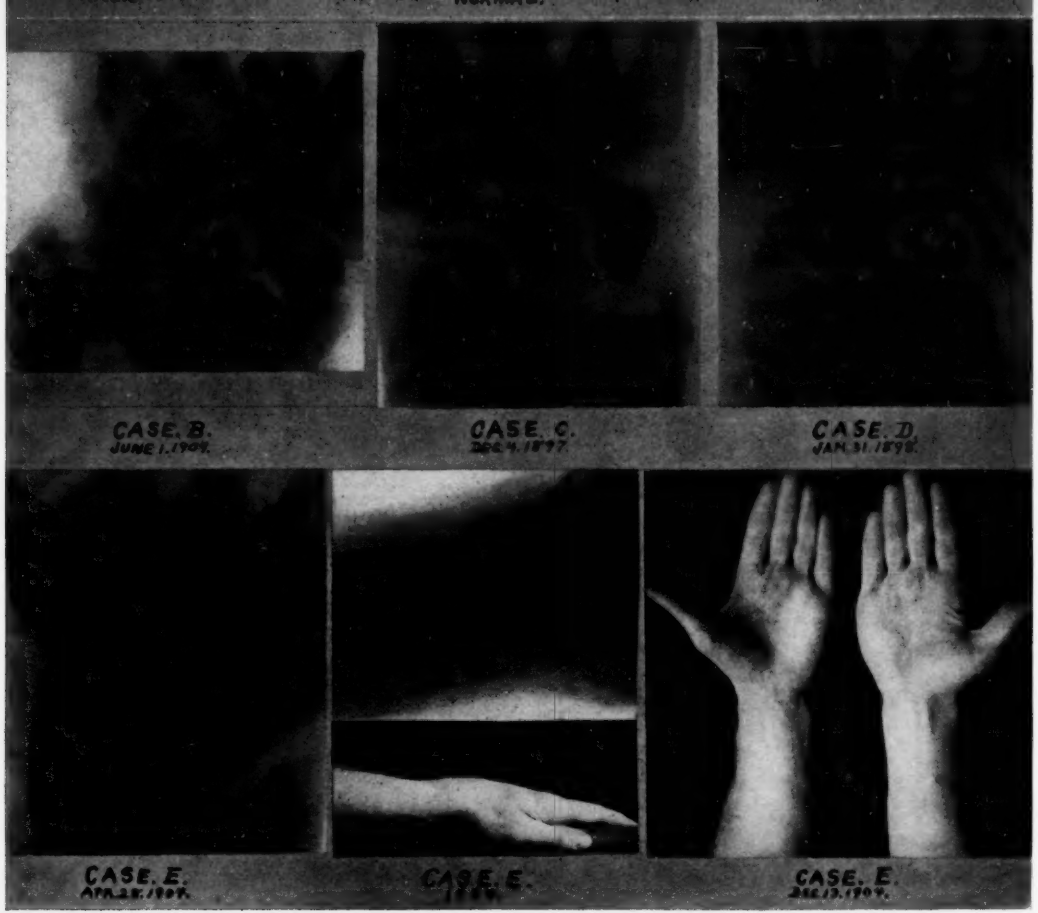
"In my hospital service of three months' operating this summer I was not inconvenienced at all by the wrist, except at first would feel pain on certain motions requiring leverage at the wrist. Now the only times of inconvenience or pain are in trying to use the wrist with too great force either in pushing or lifting.

"Improvement is still taking place, so that I feel that six months more will give me almost a perfect wrist."

CASE XVII.—F. U. B., Jr.; clerk; aged twenty years; male. On October 1, 1903, he fell backward in a boat, striking the back of his right wrist against the side of the boat. He says that there was much local tenderness and pain at the time, and all motions of the wrist were painful. There was no ecchymosis.

He was brought to my clinic on April 28, 1904, by Dr. J. H. Wright. At this time there was some thickening about the scaphoid bone and marked tenderness in the anatomical snuff-box. There was no perceptible change in the bony landmarks, but slight limitation of flexion. Extension was limited to about one-half, adduction and abduction were normal. There was decided spasm in extension, and pain if any motion was forced beyond the degree easily obtained by active extension. It chiefly interferes with him in pushing, as in lifting on the arm of a chair when he rises from a sitting posture, or pushing open a heavy door. It hurts him to twist the wrist. The X-ray in this case shows a fracture of the right scaphoid at the junction of the middle and proximal third.

The X-ray suggests that there are three fragments, but only


CASE. B.
JUNE 1. 1901.
CASE. C.
DEC. 4. 1897.
CASE. D.
JAN. 31. 1898.
CASE. E.
APR. 28. 1904.
CASE. E.
CASE. E.
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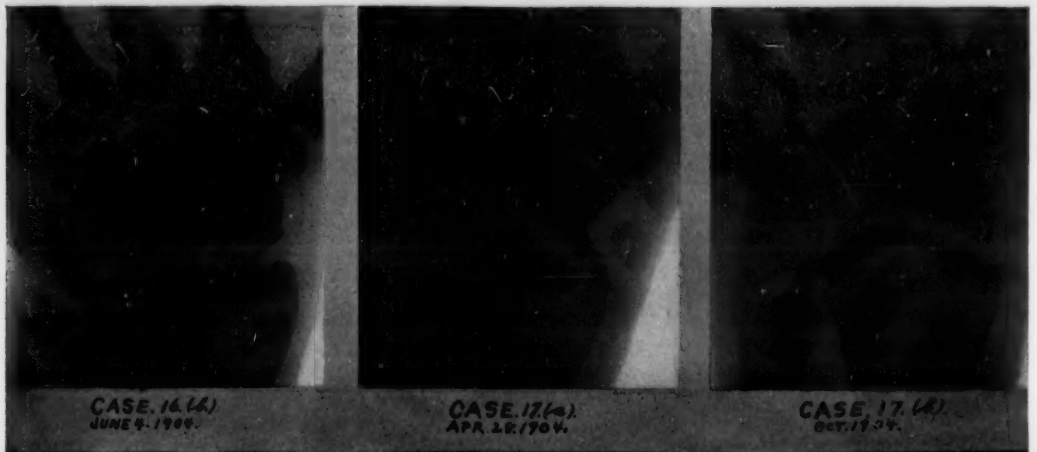
CASE. 16. (4)
JUNE 9. 1904.
CASE. 17. (4).
APR. 28. 1904.
CASE. 17. (4).
OCT. 1904.

CASE. 18.
APR. 15. 1904.
CASE. 18
NORMAL.
CASE. A.
1896.

two can be positively affirmed. From the X-ray it is impossible to tell whether union has actually occurred. The other scaphoid shows no departure from the normal. Operation on April 30, 1904. Ether. Dr. H. M. Chase assisting.

A longitudinal one-half inch incision was carried through the posterior annular ligament of the wrist between the long extensors of the wrist and the extensors of the fingers. The upper end of the incision was just at the edge of the lower end of the radius. Retraction exposed the radial surface of the scaphoid bone. There was an excess of synovial fluid in the joint, although no distention. With slight abduction a transverse fracture was seen across the articular surface of the scaphoid bone at the junction of the middle and lower third. When the wrist was moved, it was observed that the two fragments moved separately, though to a very slight extent. The ligamentous attachments of the proximal fragment to the dorsal ligaments of the wrist and to the semilunar bone were divided with a tenotome. A blunt dissector was introduced into the fissure between the two fragments and the proximal fragment torn from its anterior attachment and delivered through the wound. A few crumbs of bone adhering to the anterior ligaments were then removed with the scissors, and a small rice-like body which was free in the joint also removed. The free surface of the distal portion of the bone which still remained in the joint had the appearance of a recent fracture, except that the surface was more pale and smoother and seemed to be covered with synovial membrane. It did not bleed freely.

The ligaments divided by the incision were not stitched together because they seemed to approximate closely enough without stitches. A subcutaneous silkworm-gut stitch was passed through the lips of the skin wound, but was not tightened. This was done to allow the escape of oozing blood and synovial fluid from the wound.

The patient had a comfortable night, very little pain, and did not require morphine. The subcutaneous silkworm-gut stitch was pulled tight the following day.

May 3. Wound examined. Slight swelling of the wrist and superficial redness. Temperature, 99.5° F.; pulse, 100. No pain.

May 7. No sepsis. Splint shortened to metacarpophalangeal joints.

May 9. Fingers move perfectly without pain, and wrist,

though still slightly swollen, is not tender. Fifteen or twenty degrees of active motion without pain. Splint reapplied.

May 26, 1904. Considers wrist better than before operation. Still spasm in extension but not so marked. Flexion within twenty degrees of normal. Extension forty-five degrees. No pain in ordinary use unless motions are forced.

October 23, 1904. Perfectly satisfactory wrist; does not interfere with work or gymnasium exercises. No tenderness in scar or in snuff-box. Extension within ten degrees and flexion within five degrees of normal. Slight tenderness, but no spasm, when forced motions are made. Snuff-box feels smaller than normal.

CASE XVIII.—C. M.; yacht rigger; aged thirty years; male. Came to Massachusetts Hospital, April 15, 1904, for treatment of secondary syphilis. Incidentally, he called the attention of Dr. R. B. Greenough, under whose charge he came, in the Genito-Urinary Department, to his right wrist, which gives him a good deal of annoyance.

He said that in the winter of 1897 he was skating fast and ran into another man, so that his flexed (?) wrist caught the blow and was bent forcibly between his own chest and the body of the individual who ran into him. He did not go to a doctor, but applied liniment to the wrist for two months, and then went to work. He has continued at work steadily until two days ago. The wrist had been practically well until a week ago. He has always had limitation of motion, but no pain. He does not attribute the recent soreness of his wrist to any especial injury.

The symptoms were so characteristic of fracture of the scaphoid that Dr. R. B. Greenough called my attention to it, and an X-ray confirmed the diagnosis. There was the characteristic swelling and tenderness over the scaphoid bone, particularly in the snuff-box; all extreme motions were painful, and extension beyond fifteen degrees was prevented by involuntary spasm. The wrist could be flexed about two-thirds the normal amount before it gave pain.

The X-ray shows a transverse fracture of the scaphoid in its middle portion, with very little separation of the fragments. There is little secondary change about the edges of the fracture, which exactly resembles a recent case. There seems to be no attempt at callous formation. The scaphoid of the other wrist shows no sign of a fault in its bony structure.

(To be continued.)

FRACTURES OF THE TARSAL BONES.[1]

BY DANIEL N. EISENDRATH, M.D.,

OF CHICAGO, ILLINOIS.

THE importance of the early diagnosis and the institution of the proper treatment of fractures of the tarsal bones is well recognized at the present time. Prior to the routine use of X-ray pictures by progressive surgeons, injuries of these bones were thought to be comparatively rare, and many of the cases were treated as severe sprains, etc. In 1894, Gaupp (*Beiträge zur klinische Chirurgie*, Vol. xi) was able to collect sixty cases of fractures of the astragalus. In looking over the literature of the subject, the writer was surprised to find few cases relatively of fractures of the other tarsal bones reported.

It is only within recent years that we have begun to diagnose fractures of the astragalus and calcaneus, and I shall attempt to show by the report of some cases the necessity of making such a diagnosis as early as possible.

Injuries of the other tarsal bones are so rare that I shall confine this paper to the consideration of fractures of the astragalus and os calcis.

Surgical Anatomy.—The principal points of interest in the surgical anatomy of these two bones are that the astragalus, through its articulation with the tibia and fibula, bears the entire weight of the body, with the aid of its fellow of the other side. This portion (trochlea) corresponds to the body of the bone, and in falls upon the feet one can see how it is caught between the os calcis lying beneath it and the malleoli, and thus crushed. The neck of the astragalus joins the body with the head (the latter articulating with the scaphoid), as can be seen in an X-ray of a normal foot (Fig. 1). This

[1] Read at the annual meeting of the Western Surgical and Gynæcological Association, December 28, 1904.

narrow neck of the astragalus is the most fragile part of the bone, and hence the most frequently broken.

The os calcis placed beneath the astragalus assists it in supporting the weight of the body, and like it is subjected to a crushing force in falls from a height.

In addition, it has attached to its tuberosity the powerful tendo-Achillis, which plays a great rôle in producing fractures of this bone. The astragalus and calcaneus are firmly bound to the tibia and fibula, to the other tarsal bones, and to each other by powerful ligaments, so that at times a force may tear such a connecting band of fibres, or cause these structures to tear away a portion of the bone itself.

Mechanism.—Fractures of the astragalus and calcaneus may be produced in one of six different ways, given in their order of frequency:

1. Compression fractures. These form the larger number of the cases. They occur, as is shown in Cases I, II, and III, reported below, by the patient falling from a height and striking upon the ground, so that the sole of the foot receives the major part of the weight of the body. The latter is transmitted to the astragalus and os calcis, which are wedged in between the bones of the leg and the surface struck, and are crushed or compressed, so that they must break. Such compression fractures are frequently associated with fractures of the malleoli, or with a dislocation of the astragalus. The plane of fracture varies. It may be horizontal, vertical, or oblique. There may be simply a division of the bones into two large fragments, or they may be so splintered as to be scarcely recognizable.

2. Fractures of the neck of the astragalus following sudden dorsal flexion of the foot. In this variety the line of fracture is in the frontal plane, the anterior edge of the tibia impinging upon the neck, and thus cutting its way through. Such fractures are frequently associated with a fracture of the inner malleolus.

3. Fractures of both astragalus and calcaneus following forced supination or pronation of the foot. These are in all

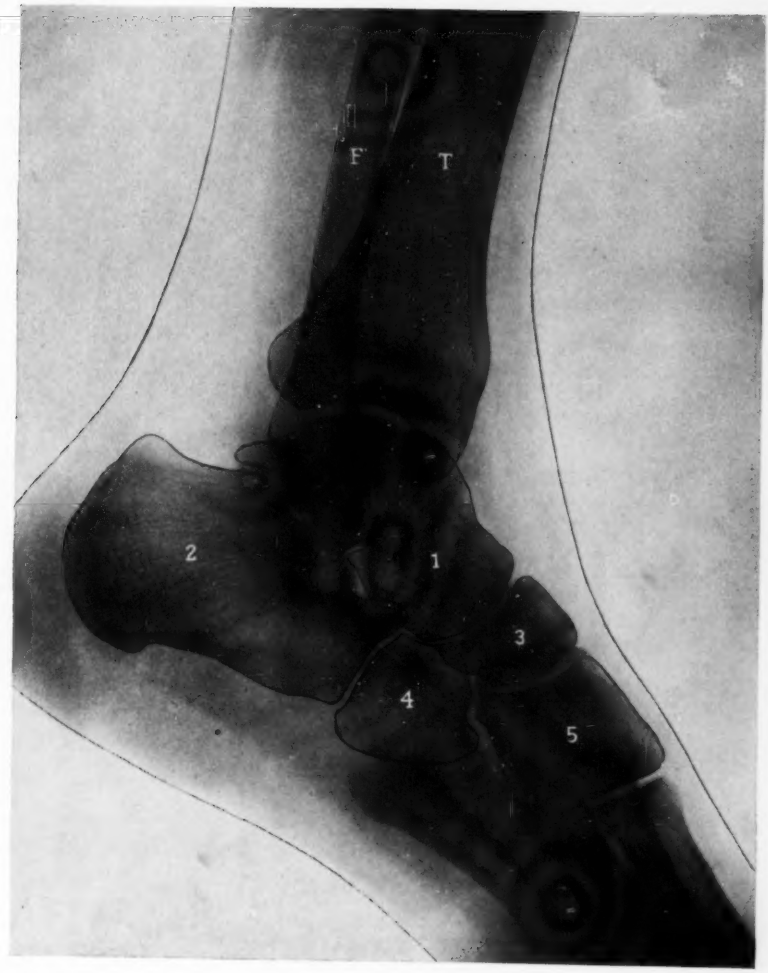

FIG. 1.—X-ray of normal foot. F. Fibula. T. Tibia. 1. Astragalus. 2. Os Calcis. 3. Scaphoid. 4. Cuboid. 5. Cuneiform.

probability due to the fact that the interosseous ligaments have in many instances greater resisting power than the bones, and probably pull the bones apart, a variety of tearing fracture so well illustrated in the next method.

4. Fractures of the os calcis which result from forcible action of the muscles of the calf. In this variety the os calcis, as in Cases IV and V, is most frequently fixed, and the sudden contraction of the powerful gastrocnemius and soleus muscles really pulls the tendo-Achillis from its attachment to the tuberosity of the os calcis, or carries a portion of the latter with it (Fig. 5).

5. Crushing fractures. In this variety the other tarsal bones are also involved. It follows such accidents as being run over, etc.

6. Gunshot fractures. All of these, with the exception of the last two, may be simple fractures, with or without noticeable displacement of fragments.

In many cases there is no important injury of the soft parts, the latter being usually found more or less contused. In other cases the fragments may penetrate the skin, or may so press upon the skin as to cause secondary necrosis, the prevention of which is of the utmost importance.

Diagnosis.—For the sake of brevity, I shall mention the symptoms and diagnosis together, as follows:

1. Marked swelling of the ankle-joint. This is present in both tarsal fractures and in sprains of the ankle, but is more marked in the former.

2. Obliteration of the normal depressions below and behind the malleoli. This is also more marked in fractures of the astragalus and os calcis (Fig. 2).

3. Crepitus and abnormal mobility. These can rarely be elicited, and but little reliance placed on them.

4. Dislocation of fragments. Such a detached portion may at times be felt beneath the malleoli, or, as in Cases IV and V, just above the tuberosity of the os calcis (Fig. 5). If felt and recognized to be a part of one of the tarsal bones, this sign is of the greatest value.

5. Lowering of the malleoli through diminution in thickness of the astragalus or os calcis. This is very seldom sufficiently marked to be of value, on account of the swelling.

6. Shortening of the foot when found is of great value.

7. Abnormal positions of the foot, such as pes valgus or pes varus, if fixed, are also of confirmatory value.

8. X-ray examination. This has been adopted as the most accurate means of diagnosis. In every case one should, however, compare the picture of the injured foot with an X-ray of the normal one.

9. History of injury is of great value, as it so frequently follows falls from a height.

To sum up, the following are of the greatest value in making a diagnosis of fractures of the tarsal bones, viz., palpation of a fragment, pes valgus or varus traumaticus, the X-ray examination, and the history of the case.

Treatment.—1. *In Simple Fractures without Displacement.* In these the foot should be immobilized at right angles, best of all in a removable cast, well padded around the ankle and heel. Massage should be begun on the third or fourth day, in order to reduce the peri- and intra-articular effusion, and prevent atrophy of the leg muscles. The cast should be worn for eight weeks, and at the end of this time the patient gradually permitted to put his weight on the foot. Convalescence may be delayed, as in many cases of simple sprain, by the presence of a flat foot (pes valgus traumaticus) following the injury. The pain and discomfort caused by this condition can be quickly relieved by a suitable steel insole.

2. *In Simple Fractures with Displacement.* If there is the least danger of secondary necrosis of the skin through a fragment impinging on it, it is best to convert the fracture into a compound one, taking extraordinary pains to secure aseptic surroundings, etc. If the fragment lies laterally, it can be easily removed. If it lies behind the ankle and is complicated by detachment of the tendo-Achillis, the latter should be sutured, as in Case IV, to the body of the os calcis. If either the astragalus or os calcis are so badly splintered as to render

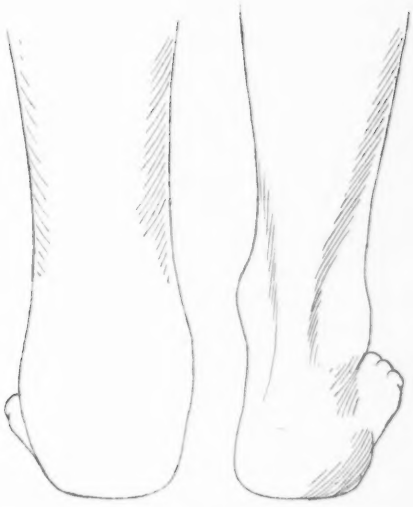

FIG. 2.—Outlines of normal ankle and of ankle after fracture of the tarsal bones. Note how depressions are marked in normal (right) ankle and are obliterated in pathological (left) ankle.

their retention impossible, they may be removed without marked loss of function in the foot.

3. *Compound, Crushing, and Gunshot Fractures of these Bones.* One should be guided by the same rules as apply elsewhere in the treatment of such injuries of the extremities.

CASE I.—*Compression Fracture of Os Calcis; Secondary Necrosis of Skin; Acute Septic Infection; Amputation of Leg.*—J. L., engaged as painter in the Stewart Building, of Chicago, was working at the level of the eighth floor of the elevator shaft, when his scaffolding was struck by a neighboring elevator cage during its ascent, and patient was thrown to the bottom of the shaft, a distance of eighty feet. He stated that he had tried to grasp some of the ironwork of the floors when falling, and this probably broke to some extent the force of the fall. He fell directly upon the sole of the left foot, and was conveyed to an adjacent hospital. I did not see this patient until the second day after the injury. Prior to that time the treatment had consisted of simply placing the limb on a splint, immobilizing it. No effort had been made to disinfect the skin. When seen by me on the second day after injury, his temperature was normal, the surrounding tissue around the ankle-joint was enormously swollen, and there were evidences of deep-seated hæmorrhages. The foot was so painful that it was impossible to make any examination, and an X-ray was not at my disposal. I was unable to get any crepitus by gentle manipulation. The surrounding skin was disinfected, and the patient placed on long splint with foot at right angle. Suddenly, upon the eighth day after the injury, the patient's temperature, which had been normal up to that time, rose to 103° F.; pulse, 140; and there were local evidences of an acute infection. Amputation was advised on account of the severity of the infection, and proved to have been the wiser plan. Examination of the amputated limb showed that there was an extensive infection of the cellular tissue of the entire foot and lower third of the leg. There were also evidences of extensive contusions of the soft parts, the os calcis was broken into many pieces, and there was a slight chipping of the cartilaginous surface of the astragalus. There were no fractures of the malleoli, and the patient made an excellent recovery.

This case illustrates how compression fractures of the os calcis arise, and shows the importance of making a diagnosis of the condition at as early a time as possible, in order to avoid what must have undoubtedly been the chief etiological factor in producing the sepsis in this case, and that is the secondary necrosis of the skin through impingement of the fragments upon it. Had this case been recognized at once as one of compression fracture of the os calcis, and a careful search made for fragments which might interfere with the circulation of the skin, I have no doubt that we could have avoided the unfortunate necessity of amputation.

CASE II.—E. W., aged forty-eight years, was admitted to my service in the Cook County Hospital with a diagnosis of a severe contusion of the foot and sprain of the ankle-joint, having fallen forty feet from a shed and landing on his feet. Examination showed the enormous swelling around the ankle-joint and obliteration of the depressions which normally exist in front, below, and behind the malleoli. We were suspicious, on account of the severe pain and the enormous amount of swelling, of a fracture of the os calcis or astragalus, and an X-ray was taken. It showed, as can be seen by reference to Fig. 3, an extensive comminution of the os calcis, confirming our previous suspicions. The skin of the foot and leg was carefully disinfected, and the limb placed in a removable cast, which was left on about four weeks. From the second week on massage was given, and at the end of the fourth week passive motion of the ankle-joint was begun. The patient was advised to use the cast for another month, being allowed to place a gradually increasing amount of weight on the limb at the end of six weeks.

This case illustrates the value of early diagnosis of such fractures, and the typical treatment as has been carried out by the author.

CASE III is the case of Dr. Sidney McLeod, of South Chicago, who had heard of my interest in this class of cases, and was kind enough to send me X-rays of this Case III, and also of a case similar to my Case IV.

CASE III.—G. G., aged thirty-five years; laborer; fell from the back porch of a second story, lighting upon his feet. Dr.

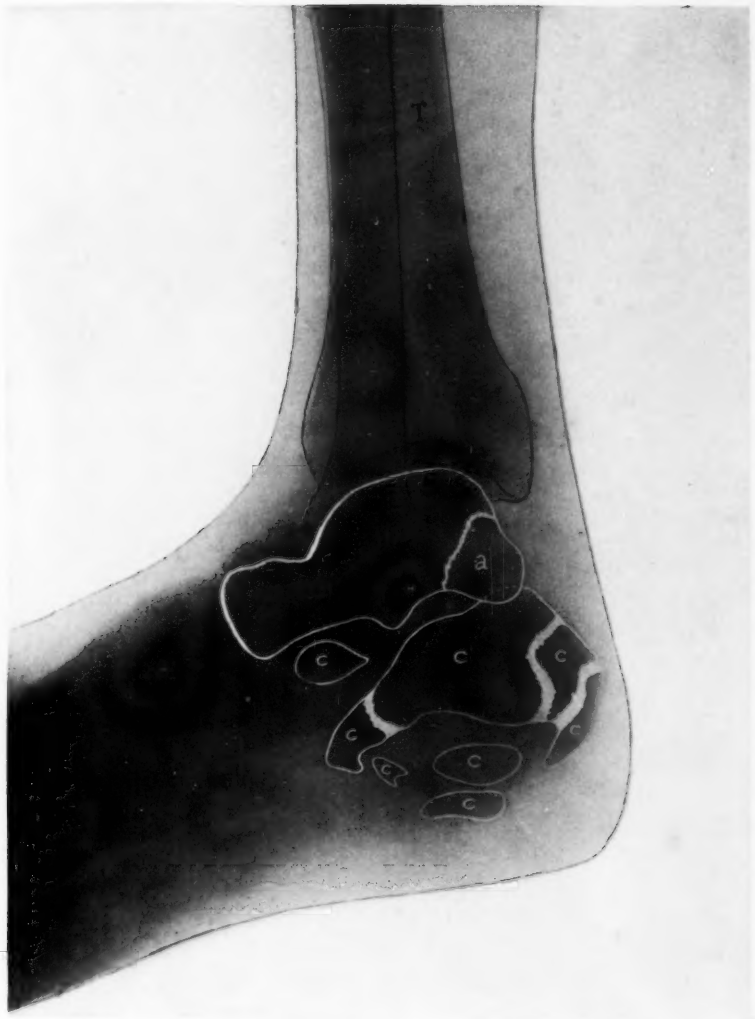

FIG. 3.—Illustrates Case III. Compression fractures of the astragalus and os calcis. Note the two fragments of the astragalus (a) and the comminution of the os calcis (c).

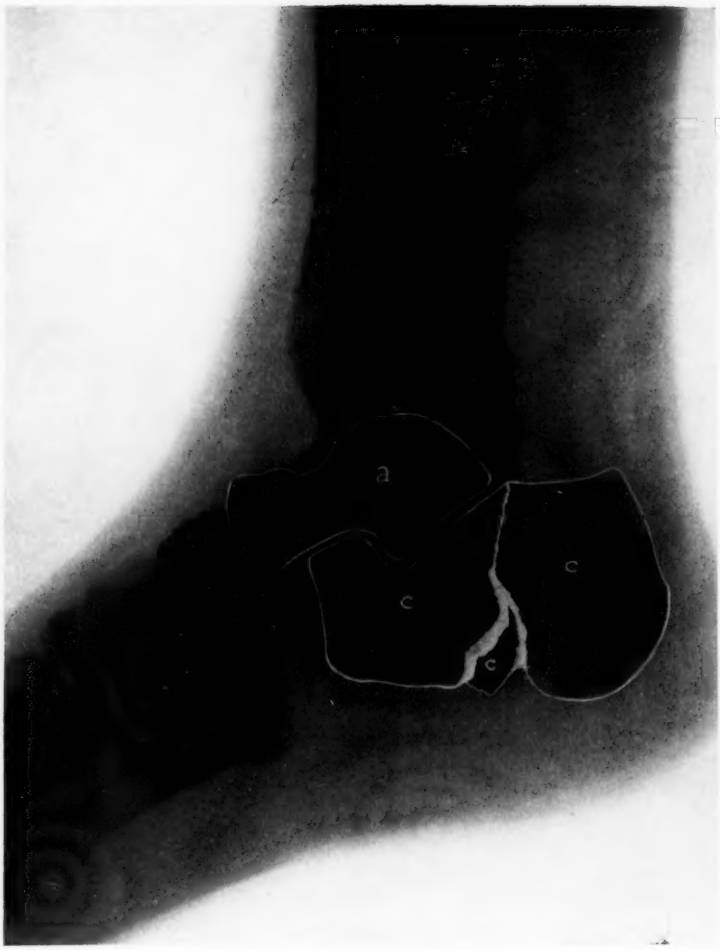

FIG. 4.—Illustrates Case III. Compression fracture of os calcis. a. Astragalus. c. Fragments of os calcis outlined in white; the heavy white lines are the spaces between fragments.

McLeod found great discoloration, crepitus, and the other usual signs of fracture. He placed the foot in a cast after the swelling had subsided. A skiagraph taken six weeks after the fracture is shown in Fig. 4, and illustrates again the same class of fracture as is shown in Case II of my own series, namely, a splitting of the os calcis into a number of fragments, the planes of fracture being diagonal or oblique to the long axis of the bone.

CASE IV.—Mrs. C. V. A., aged fifty-two years, on October 20, 1903, was getting out of her carriage, and had one foot on the step of the latter and the other (injured one) on stepping-stone, when her horse, which was headed south, was run into by a runaway horse. The shaft of the Stanhope buggy to which this second horse was attached ran into Mrs. V. A.'s horse, and knocked it over. In falling, her horse threw her backward and fell directly upon her foot and leg. She was wearing a French-heeled shoe, and her foot was held as in a vise between the stone and a low circular iron fence to the north of it. She states that as soon as the horse fell upon her, she experienced an excruciating pain in the left heel, and then fell backward into the grass-plot. She was referred to me by Dr. M. L. Goodkind, with the diagnosis of a fracture of the os calcis.

Upon examination, patient was unable to extend foot. Just above the heel there was a sharp projection, which felt firm, like a fragment of bone. It was just beneath the skin. The latter was very thin over it. A diagnosis was made by both Dr. Goodkind and Dr. Schram and myself of a fracture of the os calcis. Our theory was that the foot had been caught so as to fix the heel, and her fall backward had caused a fracture by muscular violence.

Operation, on October 22, 1903, at Chicago Baptist Hospital. After most thorough disinfection, and with Esmarch applied, an incision was made from the junction of the lower and middle one-third of the leg along its median posterior aspect to the lower border of the heel. The fragment which had projected was found to be a portion of the os calcis, about half an inch thick, which had been pulled upward by the tendo-Achillis and tilted upon edge. It was also found that the tendo-Achillis had been torn loose from this fragment with the exception of its posterior edge. The foot being forcibly extended by an assistant, the small fragment of the os calcis was sutured to the main portion of the bone by mattress sutures of kangaroo tendon (U and L of Fig. 5).

The ends of these sutures were then passed through the lower border of the tendo-Achillis, and the latter brought somewhat closer to the posterior aspect of the os calcis than normal. In addition, it was more firmly sutured to the periosteum of the main fragment of the os calcis by a number of sutures of medium catgut. Normal temperature followed operation. First change of dressings on November 3, 1903. Primary union of cutaneous wound. Silkworm-gut sutures removed. Limb again placed in plaster cast, with foot in extreme extension.

The wound healed by first intention, and the functional result has been as nearly perfect as could be wished for. She is able to extend and flex the foot as fully as on the normal side.

This case illustrates the importance of making a diagnosis of a tearing-off of a portion of the os calcis, on account of the danger of secondary necrosis over the point where the fragment impinges on the skin. Secondly, the treatment instituted here is, to my mind, the ideal one, when seen early enough by the surgeon, or even at a later period. I would, however, advise against converting such a fracture into a compound one, that is, cutting down upon the point of fracture and suturing the fragments with kangaroo tendon or some other material which will hold the bones together for a sufficient length of time, in those cases in which there is no fragment close under the skin, and in which extension of the foot brings the fragments closely together, as well as in that class of cases where aseptic surroundings cannot be secured. Unfortunately, I was obliged to take the patient to a hospital where there was no X-ray apparatus, so that it was impossible to secure a picture of the condition before operation, and the diagnosis was made entirely upon the palpation of a fragment projecting just above the tendo-Achillis, and immediately under the skin. Through the kindness, however, of Dr. McLeod, I am able to give an exact reproduction of the conditions existing in my patient before operation, owing to the fact that he was fortunate enough to secure an X-ray of an almost identical case (Fig. 6), as follows:

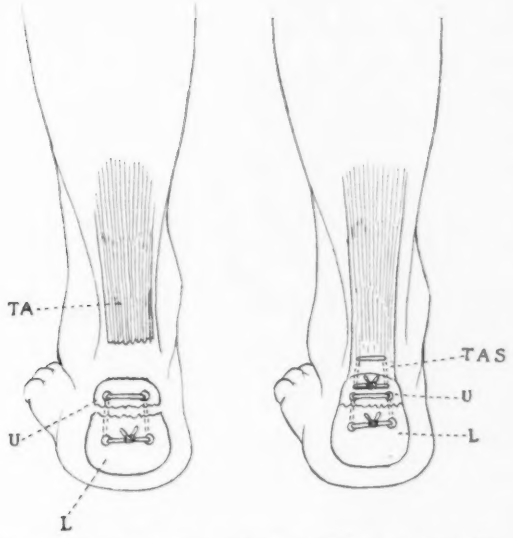

FIG. 5.—Method of suturing fragments and tendo-Achillis in Case IV. TA. Tendo-Achillis before suturing. TAS. Same after suturing. U. Upper fragment. L. Lower fragment.

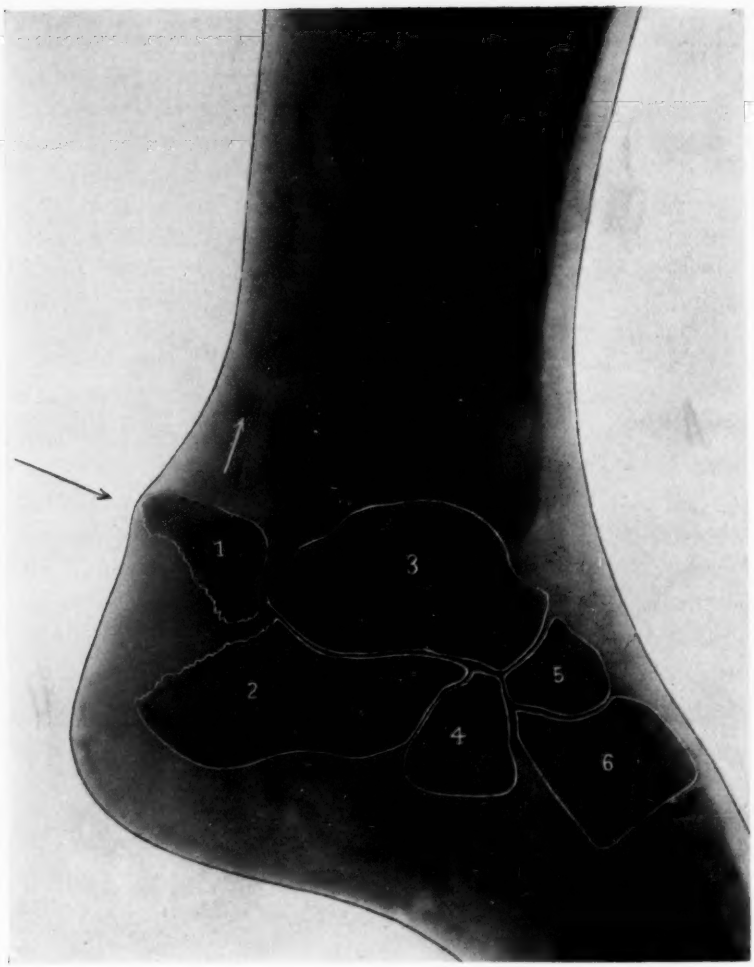

FIG. 6.—Illustrates Cases IV. and V. Tearing fracture of os calcis when heel was fixed. White arrow indicates direction of traction of tendo-Achillis. 1. Upper or torn-off fragment. 2. Main portion of os calcis. 3. Astragalus. 4. Cuboid. 5. Scaphoid. 6. Cuneiform.

CASE V.—*Fracture of Os Calcis by Muscular Contraction, causing a Tearing off of a Large Fragment of the Os Calcis from the Main Portion of the Bone.*—Mrs. R., aged sixty-two years, while walking on a sidewalk, stepped on a rotten board, allowing the heel to go through it with practically no resistance. She fell forward, throwing all of the body-weight on the ball of the foot. When first seen by Dr. McLeod immediately after the accident, the detached fragment was almost through the skin. She would not consent to operation until two days had elapsed, when an area of skin as large as a quarter, lying just over the fragment, became necrotic. She was taken to the South Chicago Hospital, where the X-ray shown in Fig. 6 was taken. Dr. McLeod made a straight incision over the tendo-Achillis and os calcis, brought the two fragments of the os calcis together with an ivory spike, reinforced by two heavy sutures of catgut. In order to suture the skin, it was necessary to cut away necrotic tissue. Good bony union resulted, but the tendo-Achillis became somewhat necrotic, but the final result has been satisfactory.

TECHNIQUE OF EXPOSURE OF THE SPINAL CORD AND CANAL; OSTEOPLASTIC RESECTION AND LAMINECTOMY.[1]

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THE object of the present paper is to discuss four aspects of the above title: The General Considerations of the Osteoplastic Resection of the Spine and of Laminectomy, and their Relative Values; The Features common to both Operations; The Technique of Osteoplastic Resection of the Spine; The Technique of Laminectomy; and under these four headings the subjects will be taken up in order.

Four of the drawings used to illustrate the present text have been modified from standard and acknowledged sources; one has been taken from the skeleton, and eight have been made from cadaveric operations.

I. *The General Considerations of the Osteoplastic Resection of the Spine and of Laminectomy, and their Relative Values.*—In an osteoplastic resection of the spine, a composite flap, consisting of skin, fascia, one or more spinous processes, a set or more of corresponding laminæ, and connecting ligaments, is partially excised *en masse*, with the constituent parts adherent, and temporarily turned backward and upward, hinging upon its own ligaments, thus exposing the portion of cord or spine involved, and is finally dropped back into its normal place at the conclusion of the operation, with practically all of its structures present and in natural relation. The soft parts are at no time detached from the spines, and only partly and temporarily detached from the laminæ.

[1] Read before the Surgical Section of the New York Academy of Medicine, December 2, 1904.

In the operation of laminectomy, or lamnectomy, as it is variously called, the spinous processes and laminæ, with connecting ligaments, of two or more vertebræ, are completely freed from surrounding structures, excised, and permanently discarded. Where, as has occasionally been done, the spinous processes and laminæ are temporarily preserved in warm normal salt solution and replaced *in situ* at the end of the operation, the procedure is not, strictly, a laminectomy, but becomes a form of osteoplastic resection without all the good points of the latter done in a typical manner.

In performing laminectomy, an attempt, at least, should always be made to do the operation subperiosteally, unless there be some pathological contraindication. Many surgeons, however, never attempt to free the spines and laminæ of their periosteum before their excision, and in the majority of cases where it is undertaken, it may be safely said that the subperiosteal feature of the operation is carried out so imperfectly as to scarcely amount to a subperiosteal method at all, so great are the difficulties of preserving that membrane in clearing these small and irregular bones. In the osteoplastic resection there is no indication to work along subperiosteal lines.

The actual opening in the spine may be of practically the same size and shape in both operations; but the tendency is to form a narrower bony opening in laminectomy, and, of necessity, the field for manipulation is more contracted than in osteoplastic resection, owing to the much nearer approximation of the walls of the wound in the soft parts.

As to difficulty of execution, when one has practised both operations equally, no appreciable difference in the difficulty of technique, worthy of a determining consideration, is experienced.

It is not open to question that the laminectomy leaves a weaker spine than does an osteoplastic resection, for the latter leaves, practically, an intact spine, while the former leaves a spine minus as many spinous processes and laminæ, with their connecting ligaments, as have been cut out. Just how much

weaker laminectomy leaves the spine it would be hard to calculate; but it is self-evident that a whole spine is better than part of a spine, even if only one-quarter or one-third of two or three vertebræ have been permanently removed, and although the bone thus represented be replaced by fibrous tissue, or partly fibrous and partly bony. It is known that patients have sometimes not been able to sit upright, or to hold their heads up, after laminectomy. And many writers advise the wearing of a spinal support for some time after a laminectomy, which would indicate their belief in its need as an adjuvant to counteract the reduced strength of the column.

Weighing all considerations involved in the selection of one or the other method of approach, the choice of operation should, in the opinion of the writer, be unquestionably given to the osteoplastic resection, as an altogether more surgical procedure,—saving to the individual, as it does, practically all of his structures, all save one spinous process,—leaving, after union, an almost intact and necessarily stronger spinal column; affording a freer and fuller field for inspection and manipulation at the time of operation; furnishing greater subsequent protection to the spinal cord, and most probably furnishing also greater immediate protection to the cord by reducing, in shutting off the spinal canal, the chances of intraspinal infection in the event of non-primary healing.

As matters stand at the present day, and in view of the recent facilities for doing an osteoplastic resection, the view held by the writer is that in cases where the conditions will admit of an osteoplastic resection, the surgeon is not justified in performing any other operation for the exposure of the spinal cord or canal, and that, therefore, the mode of approach in such cases is not a matter of choice, but of plain indication. As the positions of the saw-cuts are practically the same in osteoplastic resection and laminectomy, it is hard to see where laminectomy would ever be indicated in preference to osteoplastic resection. Though such may be the case, no such specific instance occurs to one at the present time, except, possibly, in a rare case where the main object of the operation would be to permanently

remove, for pathological growth, the site of bone involved in a laminectomy,—or possibly in a case of great comminution of the spines and laminæ (and in such case the operation would be atypical),—or where traumatism of the soft parts had left no field for the U-shaped incision of an osteoplastic resection,—any of which possibilities would be encountered only most rarely. Whenever laminectomy is elected in preference to osteoplastic resection, there being no special indication for the former, the only partial justification there would seem to be for the performing of laminectomy would be that it be done subperiosteally, and, as already mentioned, there are those who feel that a subperiosteal laminectomy is very rarely accomplished, even when definitely undertaken by the skilful.

In spite, however, of these favorable aspects of osteoplastic resection, there is no doubt but that many more laminectomies than osteoplastic resections are still done. In the last editions of two of the most generally read works upon operative surgery published abroad, not only is osteoplastic resection of the spine not described, but not even mentioned, and no method of exposing the spinal cord and canal is given except the comparatively old-fashioned laminectomy.

It would seem that the explanation of this is that the technique of osteoplastic resection of the spine is so little understood, that so many operators, satisfied with laminectomy, have not convinced themselves that osteoplastic resection is better, proving to themselves the ease of this seemingly difficult operation by its performance several times upon the cadaver, and that the mechanical advantages afforded by Hartley's preliminary excision of the spinous process immediately above the flap, and the use of Doyen's saw, are not more generally known.

As far as the writer is personally concerned, he has done several laminectomies upon the living, and a number of osteoplastic resections, as well as laminectomies, upon the cadaver; and, with his present knowledge, he feels that the interests of the patient are better conserved if he be deprived of no appreciable part of his spinal column, and that the general surgical indications are best met by the osteoplastic resection. He did

not then do the osteoplastic operation for two reasons,—first, because of not knowing of a satisfactory instrument with which to make such a bone section; and, secondly, because of having no knowledge of the preliminary excision of the spine above the flap, without which the contiguous spines must interlock and prevent the satisfactory turning back of the flap, both of which difficulties are now readily overcome.

Before considering and illustrating the operations of osteoplastic resection and laminectomy in detail, there are aspects of the technique which are common to both operations and of a fundamental importance to their performance, and which will, therefore, be first mentioned and pictured as briefly as consistent with their understanding.

II. *The Features common to both Operations.*—(1) Preparation of Operation-site.—The region is shaved, whether visible hair be present or not, and is made aseptic by the special antiseptic measures of the individual operator, the patient coming to the table with the part protected by dressings applied after the preliminary preparation, the final preparation being made at the time of operation.

(2) Position of Patient, Surgeon, and Assistants.—The patient lies upon a specially narrow table, in the semiprone position, as nearly upon the front of the chest as the conditions of anæsthesia will allow, being supported by cushions. The surgeon stands at the patient's back throughout most of the operation, passing to the opposite side of the table and leaning over the chest whenever it is more convenient to manipulate from that side. Two assistants are useful, one at the surgeon's side, and another opposite him, on the other side of the table, bending over the patient.

(3) Anæsthesia.—Nitrous oxide and ether, unless contraindicated for special reasons.

(4) Instruments and Accessories.—Heavy cartilage knife and medium knife; artery-clamp forceps; dissecting forceps; two pairs of special retractors with teeth blunt and long enough to reach the bottom of the wound; chisel about two centimetres (about three-quarters of an inch) wide;

Doyen saw; Gigli saw; probe with thin flat end; curved, heavy scissors for interspinous and interlaminous ligaments; small angular scissors for incising membranes of the cord; two small, toothed forceps for membranes; large and small needle-holders; fine, fully curved needles for membranes; heavy, curved needles for buried muscle sutures; straight needles for skin; plain fine catgut for membranes; twenty-day chromic gut for buried muscle sutures; silkworm gut, or silk, for skin sutures; horse-hair or catgut for intradural drainage; tubing or gauze for extraspinal drainage; gauze for packing wound; hot normal salt solution for hæmorrhage.

(5) Landmarks of Operation.—The spinous processes corresponding with the laminæ to be removed should, if possible, be very clearly located before beginning the incision. This can always be done in backs of medium thickness, and generally in moderately thick backs upon deep pressure. The transverse processes in the dorsal and lumbar regions and the articular processes in the cervical region should also be located, in the case of the osteoplastic resection, if it be possible; but often cannot be determined until after the skin and fascia have been incised in the operation last mentioned.

(6) Manner of Incising Muscles and Aponeuroses.—While this is not a major point, attention to the principle involved will insure a more cleanly cut section in the case of osteoplastic resection, and a more complete clearing of soft parts from the spines in laminectomy than if the principle were not observed. One is familiar with the fact that the spines of a feather may be more readily and cleanly stripped from the quill by cutting from tip to base than by cutting in the opposite direction. Therefore will the section of muscles and aponeuroses be more cleanly and evenly made if made by a stout knife wielded in such a manner as to cut into, or towards, the more acute angle formed by the attachment of the muscular or aponeurotic fibres to the parts of the vertebral column, rather than towards the more obtuse angle; and especially is this the case the nearer the spinous processes one approaches. This will sometimes necessitate cutting towards

the head, sometimes towards the sacrum, according to the direction of the fibres at the site of operation, and may require stepping to the opposite side of the table. Practically, two changes in the direction of the incision on either side of the median line will fulfil these indications. It will, therefore, be seen that it is not advised to cut from skin to bone or even from fascia to bone, at one stroke, but rather with three,—one through skin and fascia and two through the musculo-aponeurotic structures,—retracting between each incision, such a procedure furnishing a wound with less raggedly cut walls (Fig. 1, A, B).

(7) Manner of Clearing Soft Parts from Spines and Laminæ.—This, as usually done, is accomplished by the combined use of cartilage knife, periosteal elevator, and raspatory, with more or less satisfactory result. The cleaning of the bones may, however, be much more thoroughly done, and by a single instrument, by using an ordinary chisel. When the incisions have been carried fully to the bones, a knife is no longer necessary. Through the incision made by the knife, a chisel (about two centimetres, or about three-quarters of an inch, wide) is carried directly to the depth of the wound, guided, if necessary, by the surgeon's left index-finger, and so directed that its bevelled edge will be turned away from the soft parts to be pried from the bones. In osteoplastic resections the blade of the chisel rests against the transverse processes in the dorsal and lumbar regions, and against the articular processes, partly covered by muscles, in the cervical region, and, from these as fulcra, the soft parts are levered off towards the spines (Fig. 6, D). In a laminectomy the chisel-blade rests against the spinous processes, and from these as fulcra the soft parts are pried out of the bony groove towards the transverse processes in the dorsal and lumbar regions, and articular processes in the cervical (Fig. 10, C). This use of the chisel is exceedingly satisfactory, its sharp edge easily and thoroughly removing all the soft parts, and probably leaving a cleaner bony bed for the saw than is accomplished in any other way. This result is not so well secured if the bevel of the chisel is turned towards the parts to be removed.

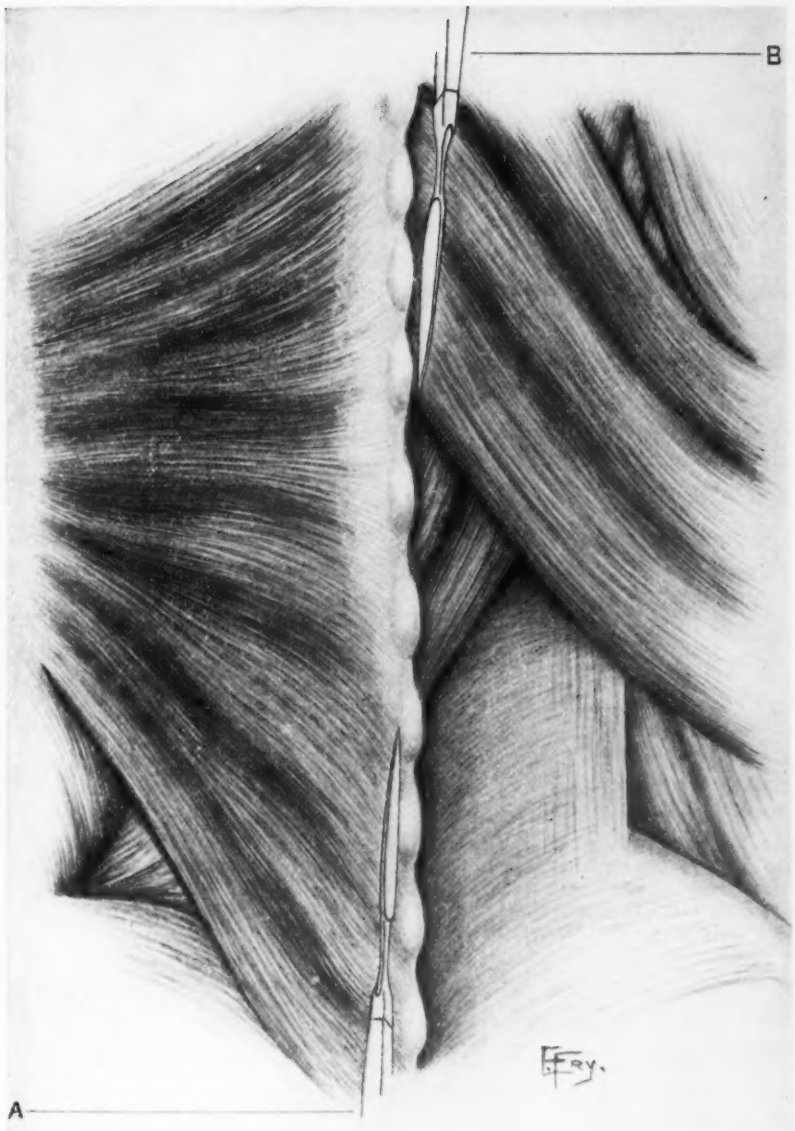

FIG. 1.—Muscles of dorsal region of back, showing manner of incising muscular and aponeurotic fibres. A, Incision of lower part of trapezius downward into the acute angle formed by its fibres with the spine; B, incision of underlying rhomboid muscles upward into the acute angle formed by their fibres with the spine. (Modified from Gray's Anatomy.)

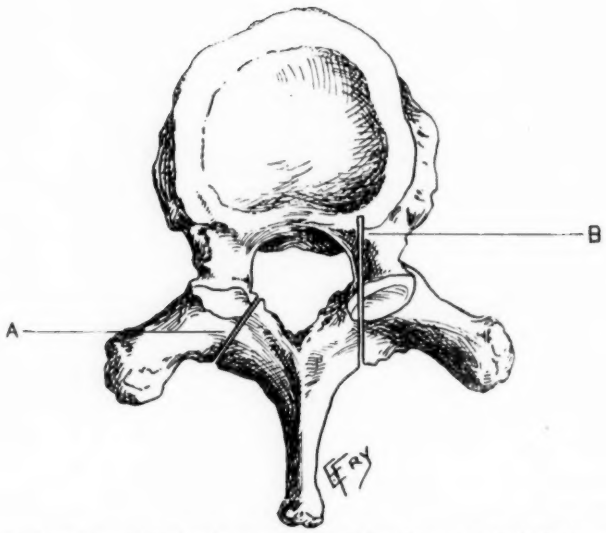

FIG. 2.—Dorsal vertebra, showing results of incisions begun at relatively corresponding sites and passing through laminæ in different directions. A, Proper section, cutting lamina at right angle to its surface and entering spinal canal; B, improper section, passing through lamina parallel with general direction of spinous process and entering pedicle of vertebra and on into body. (Modified from Quain's Anatomy.)

(8) Manner of Dividing the Laminæ.—This step, in either operation, is of paramount importance, and the manner of its performance, as far as the actual making of the saw-cut is concerned, is the same, whether the operation be osteoplastic resection or laminectomy. And the principle is also the same, as far as the direction of the section is concerned, no matter with what form of instrument the division of bone be made. This important principle is that the instrument should have its edge placed upon the laminæ at or a little to the outer side of their centre, and be made to cut its way through the laminæ strictly at a right angle to the general direction of their surfaces (Fig. 2, A). Even if the edge of the bone-cutting instrument enter in about the same site as just described, and the section be made, as so often done by beginners, parallel with the general direction of the spinous processes, the chances are that the section will pass on into the solid articular processes and pedicles, and, if continued, on into the bodies of the vertebræ (Fig. 2, B). The writer has observed the marked tendency to this serious error upon the part of students, who really often do not appreciate their difficulty until it is pointed out to them upon the skeleton. The error, once made, is hard to correct; it is absolutely impossible to go ahead upon that straight line; it is hard to start a new saw-cut, and often, much chagrined, one is at a loss to know what to do and is tempted to chisel his way through. It is better, however, to persevere with the saw until the groove of a new cut is made in the right direction.

(9) Instrument for Making the Bone-sections.—Doyen's saw, in the judgment of the writer, is the instrument, *par excellence*, for all bone- sections which are necessary in exposing the spinal cord and canal. It is useless to more than mention the many means that have been resorted to to divide the parts of the vertebræ, such as excision of the spines with bone-pliers, followed by cutting away the laminæ with bone-cutting forceps, or sawing them off with Gigli or chain saw; dividing the laminæ directly by bone-cutting forceps, one blade of which has been thrust through an interlaminous ligament; chiselling

through the laminæ in parallel lines (at the cost of much jarring and irregular division); the use of small trephine-openings, the intervening laminæ being cut away, and the use of the Hey saw. Doyen's saw is, practically, a Hey's saw with an adjustable guard, and while it seems a rather unsatisfactory instrument for the purpose intended by its author (namely, cutting through the skull between the burr-openings in cranial work), it is an almost perfect instrument for work upon the spine. The writer has had no experience with motor saws in this connection, nor seen any at work upon the spine, and while inclined, on principle, to that form of saw, he knows at present of no instrument more admirably adapted for special work than the Doyen saw for spinal sections (Fig. 3).

(10) Hartley's Preliminary Excision of the Spinous Process immediately above the Flap in Osteoplastic Resection of the Spine.—While this procedure is not common to both osteoplastic resection and laminectomy, and consequently does not strictly come under this division of the subject, yet it is a fundamental feature of the osteoplastic resection, and its general principles will, therefore, be briefly described here. It is difficult to see how an osteoplastic resection is possible without first removing the spine immediately above the flap to be turned back. Most markedly in the dorsal region, and even in the cervical and lumbar regions, will any lower spine quickly become interlocked with the one just above if an attempt be made to turn it backward and upward. So that without the preliminary excision of the spine above, the flap below can only be turned backward and upward by main force, and often a considerable degree of force is necessary, during the exercise of which bony portions of contiguous vertebræ may be broken, or other damage done. This preliminary step to the main operation may, therefore, be regarded not only as a most useful feature, but almost as a *sine qua non* of the operation as a whole. The manner of its execution will be described more in detail under the osteoplastic resection.

(11) Control of Hæmorrhage.—The three stages at which hæmorrhage is apt to be encountered are: after making

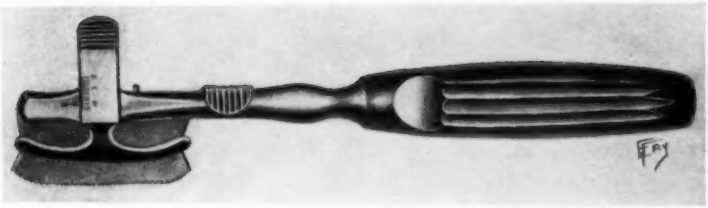

FIG. 3.—Doyen's saw, the guard set at 10 mm. ($\frac{2}{5}$ in.) (Modified from The Kny-Scheerer Company's Catalogue.)

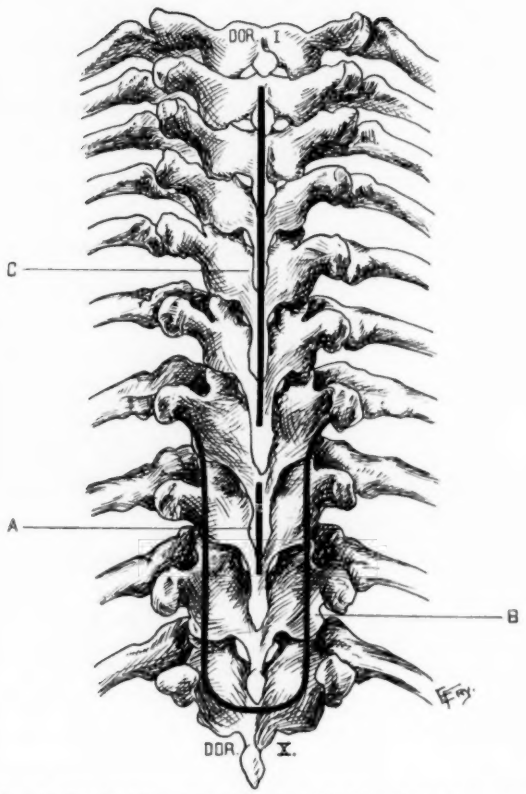

FIG. 4.—Lines of skin incisions in relation to underlying bones in osteoplastic resection and in laminectomy. A, Line to remove seventh dorsal spine in Hartley's preliminary operation of excising the spinous process of the vertebra immediately above those forming part of the osteoplastic flap; B, modified U-shaped incision outlining the osteoplastic flap for turning back the eighth and ninth dorsal spines and laminæ; C, line of incision for laminectomy of third, fourth, and fifth dorsal spines and laminæ. (Drawn from the skeleton.)

the skin and fascial wound; during the incision of the muscles of the back; and after opening the spinal canal, in removing or incising the vascular fatty areolar tissue from around the membranes. Hæmorrhage from visible vessels encountered prior to reaching the spine should be controlled by artery-clamp forceps, followed by ligature or torsion. General oozing and hæmorrhage from undetectable sources (which form the chief bleeding) should be arrested by gauze packing, or by flushing with hot normal salt solution, and by alternately working upon the two sides of the wound. Intradural bleeding from the vascular fatty areolar tissue surrounding the cord, and which is chiefly venous, should be stopped by pressure with gauze held in forceps.

III. *The Technique of Osteoplastic Resection of the Spine.*—Two distinct operative steps are here undertaken,—the preliminary excision of the spinous process above the flap, and the formation and turning-back of the osteoplastic flap. The nature of the operation has been briefly described under General Considerations.

(A) Preliminary Excision of the Spinous Process immediately above the Osteoplastic Flap (Hartley's Operation).—This preliminary operation may be considered under the following headings: Incision; Exposure of Spinous Process; Severing of Supra- and Inter-spinous Ligaments; Excision of Spine; Temporary Packing of Preliminary Wound; Final Suturing of Preliminary Wound.

(1) Incision.—A vertical incision is made directly in the median line; its centre over the spinous process to be excised, and extending in length from the tip, or near the tip, of the spine above to the tip, or near the tip, of the spine below (Fig. 4, A).

(2) Exposure of the Spinous Process.—The above incision is carried through skin and fascia directly onto the spinous process mentioned. The lips of the wound are then well retracted, and the spine in question is exposed fully to its base by prying away the overlying and closely attached soft parts by means of a chisel used against the spine as a fulcrum,

in the special manner described under General Considerations. This freeing having been accomplished, the soft parts are strongly drawn aside by means of retractors, which also serve the part of protectors of the soft parts during the use of the saw (Fig. 5, A, A). A subperiosteal exposure of the spine should be attempted.

(3) Severing of Supra- and Inter-spinous Ligaments.—These ligaments are now to be divided, both in order to sever this spine from the one below and to prepare a passage for the Gigli saw. This division of ligaments may be made with a knife, but can be better and more readily accomplished by means of curved scissors whose concavity is held upward. Having passed through the supraspinous ligament, the interspinous ligament is divided down to the ligamenta subflava. The spinal canal should not be opened in this procedure.

(4) Excision of the Spinous Process.—A passage-way having been thus provided, a Gigli saw is carried deeply down to the very base of this spinous process and the entire process removed (Fig. 5, B, B). Care is exercised to avoid making but a partial excision, as the remaining stump may interfere with the turning back of the flap almost as much as though the entire spine were *in situ*. Some operators cut the spine off with bone-cutting forceps; but the use of bone-cutting pliers here, as in many other instances, is unsurgical, removing, as they do, by a crude process of crushing, a part of bone which is much more cleanly and less traumatically cut away by a Gigli or other form of saw.

(5) Temporary Packing of the Preliminary Wound.—The spine of bone having been removed, the preliminary operation is for the time-being ended. The further use of this wound will be described in connection with the turning back of the osteoplastic flap. Some operators here permanently suture up the wound left by the excision of the spinous process; but it is distinctly best not to do so, as will be evident farther on. This wound should be tightly packed with gauze and temporarily left alone.

(6) Final Suturing of the Preliminary Wound.—At the

FIG. 5.—Osteoplastic resection of the spine; Hartley's preliminary operation for excising the spine of the vertebra immediately above the flap. A, A, Retractors in the wound, also serving as protectors of soft parts; B, B, Gigli saw in position for excising the entire spinous process. (Drawn from cadaveric operation.) *Note.*—The subperiosteal method is not shown here.

conclusion of the entire operation, the preliminary wound is sutured upon the same general principles to be described for the main wound, namely, buried chromic gut sutures to bring the muscle and aponeurotic structures together in the space formerly occupied by the now excised spinous process, and silkworm gut, or silk, for the skin wound, no drainage being used (Fig. 9, A, A).

(B) The Formation and Turning back of the Osteoplastic Flap.—This, the main operation, will be considered under the following divisions: Incision; Division of Muscles and Aponeurosis; Freeing of Laminæ preparatory to their Division; Division of Laminæ and Ligamenta Subflava; Division of Supraspinous, Interspinous, and Interlaminous Ligaments; Separation and Turning back of Osteoplastic Flap; Freeing of Spinal Cord from Extradural Fatty Areolar Tissue and Control of Intraspinal Hæmorrhage; Opening of Membranes of Cord; Manner of Dealing with Incised Membranes; Reposition of Cutaneomusculo-osseous Flap; Deep Buried-suturing of Muscles and Aponeuroses; Skin and Fascial Suturing; Provision for Drainage when Indicated; After-treatment; Comment.

(1) Incision.—A modified U-shaped incision is used. This incision outlines the two sides and lower limit of the composite flap of skin-muscle-aponeurosis-bone-and-ligament to be temporarily turned back (Fig. 4, B). Its two strictly vertical limbs begin over the laminæ of the vertebra whose spine is to be excised, commencing to the outer side of its vertical centre, near the root of the transverse process in the dorsal and lumbar regions, and near the base of the articular process in the cervical vertebræ, and extend, on both sides, downward in straight lines, parallel with the tips of the spinous processes, until opposite the tip of the last spine to be included in the resection; here the incisions broadly curve towards the median line, meeting midway between the tip of the spinous process just mentioned and the tip of the spinous process next below. It is very essential that this broad curve should be given to the lower end of the incision rather than that a narrow contracted

curve be made, much of the ease of subsequent manipulations depending thereon. For the purpose, solely, of providing a greater influx of blood into the base of the semidetached flap of skin-muscle-and-bone, a slightly outward curve should be given to the upper ends of the vertical portions of the U-shaped incision. It might be asked how the bases of the transverse processes of the dorsal and lumbar vertebræ and the bases of the cervical articular processes may be recognized prior to the skin incision; in reply to which it may be said that the tips of these processes themselves (transverse and articular) may generally be felt upon firm pressure made upon backs of medium thickness, and, having recognized the tips of these processes, their corresponding bases lie approximately midway between their tips and the median line formed by the apices of the spinous processes. Where the tips of the transverse processes of the dorsal and lumbar vertebræ and tips of the articular processes of the cervical vertebræ cannot be recognized by palpation at all, it may be stated that the tips of the transverse processes of the dorsal vertebræ lie, in the average skeleton, about three to 3.5 centimetres (one and one-fourth to one and three-eighths inches) from the tips of the dorsal spines, the tips of the lumbar transverse processes about four to five centimetres (one and five-eighths to two inches) from the tips of the lumbar spines, and the tips of the cervical articular processes about three centimetres (one and one-fourth inches) from the centres of the cervical bifid spines.

(2) Division of the Muscles and Aponeuroses.—The direction of the incision through the layers of muscles and aponeuroses at the different layers, and the reasons therefor, have been given above under General Considerations. The incision through skin and fascia will, upon retraction, have exposed muscle or aponeurosis, according to the site of operation. The margins of the skin and fascial wound having been retracted and hæmorrhage controlled, the muscular and aponeurotic layers in view are incised in a general direction which will correspond with the acuter of the two angles which their component fibres make with the spine, and the layers below

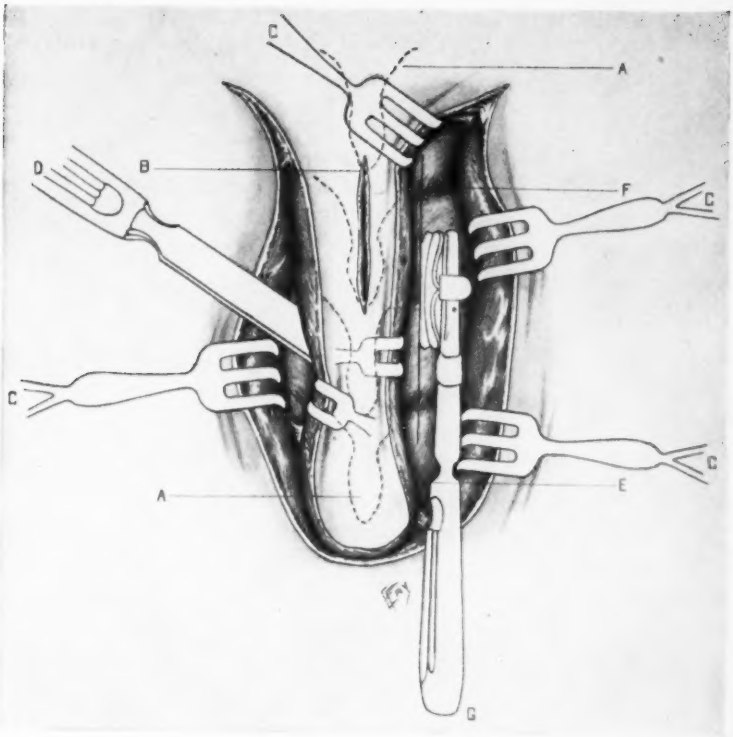

FIG. 6.—Osteoplastic resection of the spine. A, A, Position of dorsal spines; B, wound of Hartley's preliminary excision of spinous process immediately above flap; C, C, C, C, retractors of main wound; D, chisel, against transverse processes as fulcra, in act of prying soft parts from laminæ; E, lamina; F, interlaminous ligament (ligamentum subflavum); G, Doyen's saw in act of completing section through laminæ and interlaminous ligaments. (Drawn from cadaveric operation.)

similarly incised. Immediately prior to deepening the muscle incision down to the bone, it is advisable to satisfy one's self, by means of a finger introduced into the wound, that the vertical limbs of the U-shaped incision are falling well within the bases of the transverse processes in the dorsal and lumbar regions and within the tips of the articular processes in the cervical region. This precaution will insure the coming of the incision down upon the spinal column over the laminæ, which will make the clearing of the laminæ correspondingly easy.

(3) Freeing the Laminæ preparatory to their Division.—The gauze packing is now removed from that side of the U which was first incised and packed, by which time the hæmorrhage, which is usually rather free, has ceased. While instrumental retraction should be practised during the latter stage of the freeing of the laminæ, it is not necessary, and is certainly better omitted during the beginning of the freeing, owing to the small amount of room in the wound for finger and chisel. At the stage when retractors are used, they should have blunt hooks, to avoid wounding the fingers of operator and assistants, which are also in the wound; and they should be long enough to reach to the bottom of the incision. Proceeding, therefore, at first without retractors, the left index is introduced into the wound until its tip is in contact with the laminæ. An ordinary chisel, as mentioned in the Introduction, is now inserted alongside of the already introduced finger, with its edge parallel with the direction of the spines and with the bevel turned away from the parts to be pried from the laminæ, in the manner already described. A path for the Doyen saw is thus made over those laminæ which are to be temporarily turned back,—the chisel being used as a lever,—braced against the transverse processes in the dorsal region, against the articular and transverse processes in the lumbar region, and against the articular processes in the cervical region, and, with these as fulcra, is made to pry the overlying soft parts from the bony groove formed by the laminæ and interlaminous ligaments (Fig. 6, D). While the major portion of this clearing of the saw-bed can be accomplished by manipulating the chisel from the aspect

of the transverse and articular processes towards the base of the spines, a still more thorough completion of the clearing can be secured by withdrawing the chisel, turning it around (so that the bevel is towards the transverse processes), and also using it against the spines, covered by their soft parts, as fulcra, while prying away from the laminæ those soft parts lying nearer the transverse and articular processes. This manipulation is shown in Fig. 10, C, where the principle is used in the laminectomy operation. Not only should the special laminæ and interlaminous ligaments involved in the resection be completed cleared of overlying soft parts, but the lower half of the laminæ above and the upper half of the laminæ below these should also be freed, as it will be necessary for them to accommodate the end of the saw in its excursions. This additional clearing is shown in Fig. 6. When the saw-bed upon one side has been thus prepared, it is firmly packed with gauze, to control bleeding, while the opposite side is being similarly prepared and packed.

(4) Division of Laminæ and Ligamenta Subflava.—The edges of each of the vertical limbs of the wound should be retracted, one at a time, by four special retractors with extra-long blunt teeth, the wound thus presenting a rectangular shape (Fig. 6, C, C, C, and a small unlettered retractor). The guard of the Doyen saw is set at ten millimetres (about seven-sixteenths of an inch), which will give a sufficient cutting edge to pass completely through the laminæ at any portion of the spine, provided the section be made well within the laminæ proper, and at a right angle to their surface. With the guard thus set it is simply impossible to wound the cord (the cord and spine being normal), as the saw will bind after traversing the bone. As a matter of fact, the guard may be entirely dispensed with; though under such circumstances care is necessary, and the saw must be checked immediately upon the sense of lost, or lessening, resistance, as the last thickness of the laminæ is encountered. One has frequently thus used the saw upon the cadaver without other than the most ordinary precautions, and has never seen injury done in such cases; nor

has he but once ever seen the cord injured by a student during the roughest manipulation, independently of the form of instrument used for the bone division, so securely is the cord ordinarily protected by its position. The saw, protected by the guard at ten millimetres, should be used until it has cut its way completely through and is stopped by the shoulder of the guard. The sweep of the saw at each stroke should be as full as the length of the wound will allow; and the general cutting edge of the saw should be held as level as circumstances will permit, that the bone-section may be made of equal depth throughout as great a length of the wound as can be reached in one position of the saw. It is usually impossible to complete the section of one side with the saw in one position, owing to the shape and position of the handle of the saw, as the end of the saw nearer the handle will not travel the full length of the wound quite as satisfactorily as the distal end. Fig. 6, G, illustrates this principle. The surgeon, therefore, standing at the patient's back, introduces the saw first into one side and then into the other, using the instrument from below upward and sawing through the lower half of the laminæ above those to be turned back, as well as through as many of the laminæ to be resected as the teeth of the saw will engage themselves in. When division of the upper parts of both sides has been made, the surgeon, unless ambidextrous, must walk around the table, lean over the thorax of the patient (in his semiprone position), and, sawing now from above downward, complete the section of those laminæ to be temporarily turned back, as well as of one-half of the laminæ next below. The depth of the bony section may be tested from time to time by means of the flat end of a specially thin probe. This division of one-half of both the laminæ above and below those to be temporarily displaced is only necessary because unavoidable, as the saw-blade cannot be carried abruptly up to the limit of one lamina and completely divide it without also at least partly dividing a portion of the contiguous lamina (Fig. 6, E). But no practical harm is done thereby, as only a very small proportion of these two sets of laminæ is divided by the very fine blade of the saw,

and must soon solidify. The ligamenta subflava are also divided by the saw (Fig. 6, F).

(5) Division of the Supraspinous, Interspinous, and Interlaminous Ligaments.—The lowest one of the spines in the osteoplastic flap, with its corresponding laminæ, is now to be severed from the corresponding intact structures next below, involving the division of the above-mentioned ligaments. These ligaments may be divided with a knife held sidewise, but are more satisfactorily divided by a pair of curved scissors held with their concavity backward (Fig. 7, C). The process of division is aided by grasping the composite flap to be displaced and lifting the lowest spine away from its neighbor next below, thus giving the scissors more room for dividing the V-shaped ligamentous structure formed by the supraspinous and interspinous ligaments posteriorly and the ligamenta subflava to either side.

(6) Separation and Turning Back of the Osteoplastic Flap.—The detachment or loosening of the resected portion of the spinal column is best accomplished by means of the same chisel used in clearing the soft parts from the bones, and held in the same way, that is, with the non-bevelled edge towards the part to be pried out. Preparatory to thus using the chisel as a lever, the edges of one of the vertical limbs of the wound are retracted by the four special retractors mentioned above (Fig. 7, A, A, A, and a small unlettered retractor), the parts sponged dry with gauze, and the saw-cut brought well into view. The surgeon's left index-finger should be introduced into the preliminary wound through which the spinous process has been removed (Fig. 7, B), carried down to its sawn-off end and adjacent interlaminous ligaments, and held there until the composite flap has been pried out of its site, the tip of the finger greatly aiding in this manœuvre and in determining the progress of the elevation. The chisel is placed in position, with its bevelled side against a transverse process (in the dorsal or lumbar region) or against an articular process in the cervical region, and its edge, with non-bevelled surface towards the spines, engaged in the saw-cut (Fig. 7, D). The composite

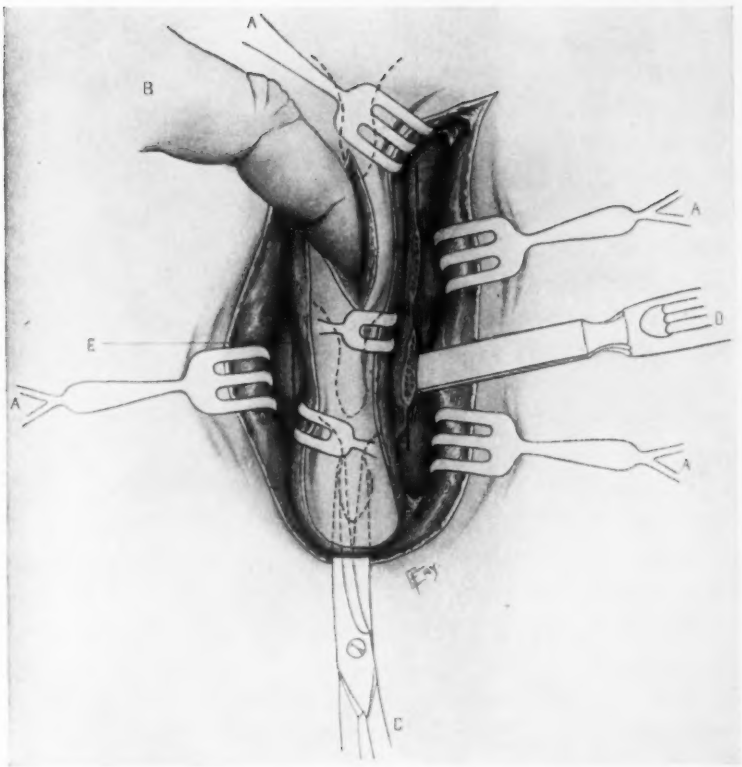

FIG. 7.—Osteoplastic resection of spine. A, A, A, A, Retractors in main wound; B, surgeon's left index-finger introduced into preliminary wound to aid in bending back of flap; C, curved scissors cutting interspinous and interlaminous ligaments; D, chisel introduced into saw-cut and supported against transverse processes as fulcra, prying out osteoplastic flap; E, opposite saw-cut. (Drawn from cadaveric operation.)

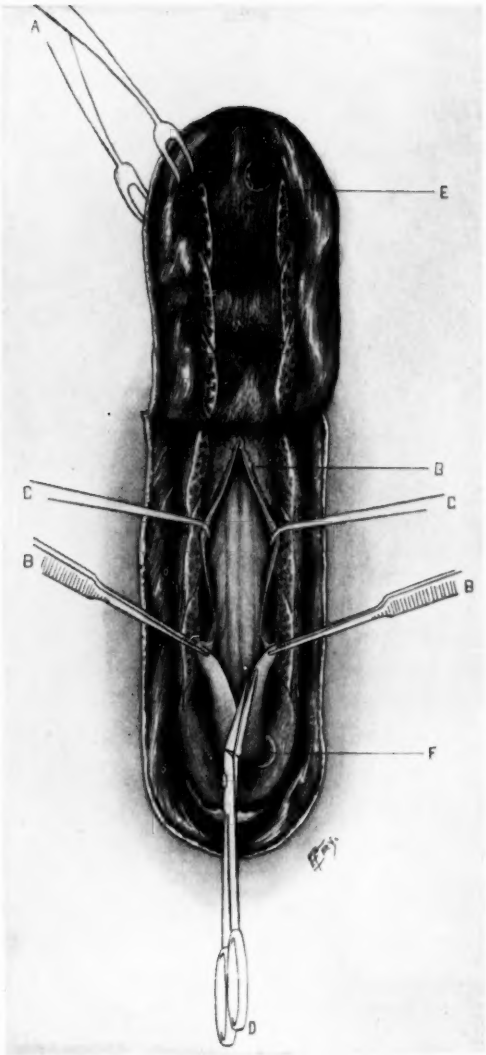

FIG. 8.—Osteoplastic resection of the spine. A, Tenaculum-forceps holding back composite flap; B, B, delicate forceps grasping and elevating membranes and forming a transverse ridge; C, C, tenacula holding apart edges of incised membranes; D, angular scissors used in incising membranes; E, half-button of bone bitten out of lower margin of last lamina in flap by rongeur forceps; F, similar half-button bitten out of upper margin of next stationary lamina below, the two half-buttons forming a circular opening, when in contact, for drainage; G, vascular fatty areolar tissue covering membranes. The stump of the excised spine is shown, in impression, through the turned-back flap. (Drawn from cadaveric operation.)

mass is seized between the surgeon's left thumb and index and steadied and gently drawn away during the prying-out process. Ordinarily, a single, light, downward pressure of the handle of the chisel will suffice to start the composite flap from its normal site, after which the entire flap can be readily turned back. This is always so if the section of bones and ligaments have been previously made complete, which should invariably be the case, and verified by sounding along the entire line of section with the flat end of a thin probe. Should the flap not readily, and without force, start backward, it argues that the section has not been fully made; and there is no alternative but to lay down the chisel and complete the division of bone with the Doyen saw, or of the ligaments holding the last spine and laminæ with scissors, as may be indicated, before going on with the levering-out process. As soon as the section is felt to be started from its bed sufficiently to get the end of the finger under the tip of the lowest one of the spinous processes, all instruments may be laid aside. With the left index-finger still in the preliminary wound through which the spine has been removed, pressing down between the stump of the excised end and the upper margin of the laminæ below, and with the right index under the last spine of the flap, the entire mass is turned backward and upward onto the patient's back (Fig. 8, A). The backward displacement of this flap is accomplished in the following way: The mass hinges over the stump of the excised spinous process, the interlaminous ligaments serving as the hinge; at the maximum of tension of the parts the upper border of the detached laminæ below is pried downward and outward from under the lower border of the intact laminæ above, and then slightly rides up over the latter in the turning-back process. This manœuvre does not so fully occur in the lumbar region, and but slightly, if at all, in the cervical region, owing to the different disposition of these laminæ and their wider separation from each other. If the line of bone-section have fallen well within the articular processes, the joints of the articular processes will not be opened. This manipulation, though exercising some violence upon the structures entering

into the make-up of the interlaminous relations at the hinge, does no permanent harm, as the parts readily drop back into their normal relationship at the end of the operation and undoubtedly soon solidify. The composite flap, once turned back, will generally lie *in situ* without restraint, or may be held so with a light retractor or tenaculum-forceps (Fig. 8, A).

(7) Freeing of the Spinal Cord from the Extra-dural Fatty Areolar Tissue, and Control of Intraspinal Hæmorrhage. —Having turned back the osteoplastic flap, the window in the spinal column is shown, corresponding in length with the number of laminæ resected, and in width with the distance apart of the saw-cuts (Fig. 8). In some cases the membranes of the cord lie readily within view and touch through the window thus formed, surrounded by a minimum of connective tissue. In other cases a more or less thick layer of vascular fatty areolar tissue may intervene between the bone and the cord (Fig. 8, G). To reach the membranes, this layer must be removed, which is best accomplished by grasping it with delicate forceps and cutting it with fine angular scissors. The hæmorrhage which results from this manœuvre, and which may be somewhat marked, is usually readily controlled by the pressure of gauze held in small forceps. The hæmorrhage will be less if this vascular tissue, chiefly venous, be cut accurately in the median line. Upon the removal of this fatty connective tissue the white glistening membranes of the cord are brought into the field. If the object of the operation have been only to expose the membranes, that object is now accomplished. If the cord itself is to be exposed, other steps are necessary.

(8) Opening of the Membranes of the Cord.—The most satisfactory manner of incising the membranes which the writer has found is the following: Two pairs of delicate, toothed forceps are taken, one held in the surgeon's left hand and one in an assistant's right hand (Fig. 8, B, B); each of these, on the same level, takes a light hold upon the membranes of the cord about three millimetres (approximately one-eighth of an inch) from the median line of the membranes (making the forceps six millimetres, or one-fourth of an inch, apart), care

being taken that the membranes alone are grasped. The tips of the forceps are now drawn gently outward and upward, away from the underlying cord, whereby a marked transverse ridging of the membranes is produced at a right angle to the length of the cord. While thus held, this ridge is cut with the points of a pair of small, angular scissors held in the right hand of the operator (Fig. 8, D). Having made an opening in the membranes, the lower blade of the scissors is passed along between the cord and theca, and the incision extended to the desired length, the holds of the forceps being shifted as the incision advances, and being subsequently maintained to retract the incised membranes, or the edges of the cut theca may be held apart with fine tenacula (Fig. 8, C, C). Upon the wide retraction of the cut membranes the spinal cord and the exit of the nerve-roots from the cord are brought well into view. The special object of the operation, if it involve the cord, is now carried out. The present paper deals solely with the manner of exposing the cord and canal, the various special conditions for which this exposure may have been made not being taken up.

(9) Manner of Dealing with the Incised Membranes.—This will pre-eminently depend upon the nature of the special operation. All bearings of the operation being favorable, it is best to close the membranes after the carrying out of the special object in view. This is done with fine, plain catgut threaded upon a specially adapted, fully curved needle held in an appropriate needle-holder. The margin of each lip of the cut theca is brought into proper relationship for suturing by being held by the delicate toothed forceps used in steadying the membranes during the incision of its structures. A continuous suture completely closing the incision is preferable.

(10) Reposition of the Cutaneomusculo-osseous Flap.—The object of the operation, as a whole, having been fulfilled, the composite flap will often fall back into accurate apposition without any effort to make it do so. It is, however, better for the surgeon to reinsert his left index into the preliminary wound through which the spinous process has been excised and

carry this finger down to the stump of the excised spine (Fig. 7, B), while with his right hand he replaces the flap, thus having a better opportunity to verify the accurate fitting of the parts. This fitting of the structures back into their original relationship should be absolute; and, fortunately, it is easy to determine whether or not it is so, and equally easy to make it so if there seems to be difficulty. This replacement is brought about by manual manipulation alone, the left index in the small wound guiding the parts at their hinge-junction. The accuracy of the apposition is verified by exposing the saw-cuts, and seeing that the parts of the laminæ on either side of the section line are on an exact level; and, when this is the case, it will be found that the shelving surfaces of the contiguous laminæ, where the interspinous and interlaminous ligaments were cut, are in accurate apposition, that the spines are in line and on a level, and that the skin margins come easily and evenly together.

(11) Buried Suturing of Muscles and Aponeuroses.—Having readjusted the composite flap, the soft parts intervening between skin and bone should be brought together by deeply buried sutures (Fig. 9, C). One would give the preference to twenty-day chromic gut, fairly stout, carried upon a fully curved needle. The cut muscles and aponeuroses are brought together in their proper layers and relations in the bite of heavy forceps, and are thus held while being penetrated by needle and suture. Two continuous sutures may be used, each passing from the upper end of one of the limbs of the U-shaped incision above to the centre of the incision below, or interrupted sutures may be applied. It is not practicable to suture together the cut edges of the interspinous and interlaminous ligaments, nor is it necessary, so closely do the parts come together, but the cut ends of the supraspinous ligament may be sutured.

(12) Skin and Fascial Suturing.—The skin and fascia should have their edges united with interrupted sutures of silkworm gut or silk. A continuous suture of a wound of this shape and extent is not apt to bring the margins so accurately together (Fig. 9, D).

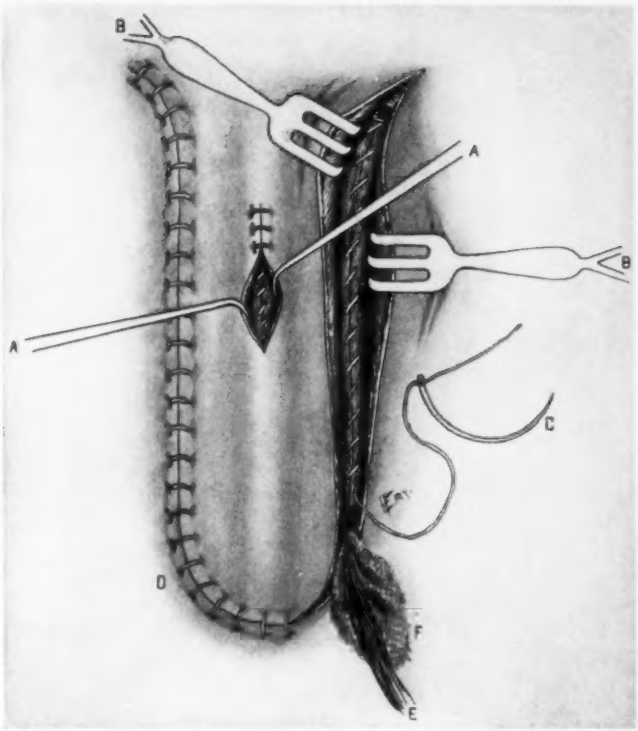

FIG. 9.—Osteoplastic resection of the spine. A, A, Retractors in preliminary wound, showing buried sutures of muscles and superficial sutures of skin; B, B, large retractors drawing back skin of main wound; C, line of continuous buried sutures of deeper parts; D, line of interrupted superficial sutures; E, intradural horse-hair or catgut drains; F, extra-spinal gauze drain. (Drawn from cadaveric operation.)

(13) Provision for Drainage, when indicated.—Opinions differ upon the subject of drainage,—some advising its use both within the membranes and in the extraspinal wound, and some its non-use. Unless there were some special contra-indications, the preference of the writer would be to completely and accurately suture the incised membranes; to shut off infection from without, and the escape of cerebrospinal fluid from within; to introduce, for from twenty-four to forty-eight hours, an intraspinal but extradural drain of a few strands of horsehair, or catgut, bringing these out between a couple of omitted superficial sutures (Fig. 9, E), incorporating them with a strip of gauze placed in the deep muscle wound and leading down to the spine (Fig. 9, F), both emerging together from the skin wound. Where intraspinal drainage is used, whether it be intra-or extra-dural, special provision must be made for it. This is best secured by biting out, with rongeur forceps, a half-button of bone from the lower margin of the lowermost lamina in the flap (Fig. 8, E), and a corresponding half-button of bone from the upper margin of the uppermost one of the intact laminæ below (Fig. 8, F), so that when the osteoplastic flap is turned back into place, the two half-buttons will afford a circular bone-opening for drainage, the drains being conducted thence out through muscles and skin as just mentioned.

(14) After-treatment.—It is conceivable, though the writer knows of no such recorded case, that, through the excision of a large number of laminæ in the operation of laminectomy, a patient might be broken into two by subsequent rough or imprudent handling, so that it might be well, in even osteoplastic resection where the operation has been extensive, to include some form of spinal splint in the final dressing immediately after operation, which could be worn until solidification of the parts had taken place through union, as after any other fracture, the patient meanwhile maintaining a strictly horizontal posture. In ordinary osteoplastic resection of average extent, and with the spine normal as to strength, the use of a splint would seem superfluous. The writer has never used any

form of spinal support following laminectomy, where the spine is left even weaker than after an osteoplastic resection. If the need of it were felt, following the convalescence of the patient, some form of leather, or leather and metal, support could be worn as long as indicated. Reference has been made to the occasional need of such a support under General Considerations.

(15) Comment.—Both during and immediately following all operations in which the membranes of the cord are opened, the patient's head should be kept lower than the body and the spine absolutely horizontal, in order to lessen the loss of cerebrospinal fluid.

Where the window in the spine has been made too narrow, through the placing of the bone-sections too near together, if more space for manipulation be absolutely demanded, there is no alternative but to bite out a portion of the margin of the opening into the spine, by means of rongeur forceps or bone-cutting pliers. If this be done to a limited extent, although there will be a corresponding gap when the osteoplastic flap is turned back into place, the flap will, nevertheless, be held in position and kept from pressing against the spine by resting upon the margins of the bone-section which have not been thus additionally cut away.

While the normal cord, in a normal canal, is not apt to be injured by any method of ordinarily careful approach, in pathological cases the need of additional care is always present.

When it is necessary to reach the anterior aspect of the spinal canal, the cord must be displaced temporarily to one side by means of gentle retraction. If such retraction should not give sufficient room for manipulation, one or two nerve-roots have been severed to afford the required additional room, and, at the end of the operation, sutured with fine plain catgut.

IV. *The Technique of Laminectomy.*—The nature of this operation has been briefly described under General Considerations. So many of the features of the operation of laminectomy are in principle common to the operation of osteoplastic resection, which has just been detailed at length, that only the

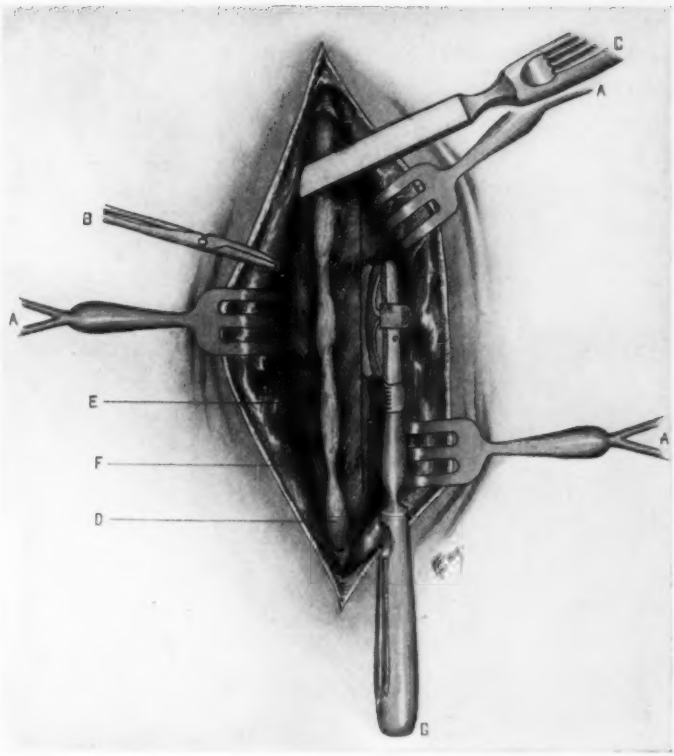

FIG. 10.—Laminectomy. A, A, A, Retractors withdrawing edges of wound; B, clamp-forceps controlling hæmorrhage; C, chisel, against spinous processes as fulcra, levering soft part away from laminæ; D, spine of vertebra; E, lamina; F, interlaminous ligament; G, Doyen saw completing section of laminæ and interlaminous ligaments. (Drawn from cadaveric operation.) *Note.*—The feature of the subperiosteal operation is not shown here.

salient and distinguishing points of laminectomy will be here mentioned.

(1) Incision.—A median incision is made directly over the centres of the apices which are, together with their corresponding laminæ, to be removed. In order to give greater room for the exposure of these spines and laminæ, the incision should begin over the spine next above and end over the spine next below those to be removed (Fig. 4, C). It is a bad practice to place the vertical incision immediately to one side of the spines, in a line along which the muscles and aponeuroses are to be subsequently separated from the bone in the subperiosteal operation (or incised in the open, or non-subperiosteal, method); for if this be done, the median lip of this wound will have to be retracted to and beyond the line of the apices of the spines when the soft parts are freed from the side of the spine opposite to the one first attacked.

(2) Division of Muscles and Aponeuroses.—These structures are divided in the same general way, in so far as the direction of incising their structures is concerned, as described under Osteoplastic Resection, paragraph 2, and as indicated in Fig. 1, A and B. But as soon as the spines are reached, the knife should be wielded firmly and made to cut its way through the periosteum to the bone, in a straight median line over their posterior aspects, from the apex of each up to a point where the apex of the spine above prevents further incision of the periosteum. The subperiosteal method should always be undertaken unless specially contraindicated; but if it be elected not to attempt the subperiosteal operation, the knife should hug the spines so closely, in deepening the incision through the soft parts, that a minimum of muscle and aponeurotic tissue be left adherent to the bones.

(3) Subperiosteal freeing of Spines and Laminæ preparatory to their Division.—Having started up the edge of the incised periosteum from the apices and posterior aspects of the spines by means of a raspatory or periosteal elevator, this process of separation may be continued; or, better, a chisel, with its non-bevelled edge towards the parts to be removed

and its blade braced against the spinous processes (articular processes in the neck) as fulcra, is made to clear the soft parts from the spines and laminæ. The edge of the chisel is carefully inserted beneath the freed margin of the periosteum, and is made to remove the periosteum first from the spines and then from the laminæ, in the form of intact a layer as possible, and as adherent as possible to the overlying soft parts. As it is impracticable, in advance of clearing each spine and its set of laminæ, to incise through the periosteum along the upper and lower borders of the spine and laminæ, the layer of periosteum on each side, corresponding with each spine and the lamina of that side, must be more or less shredded and imperfect, especially where it merges into ligamentous tissue; but an attempt, nevertheless, should be made to preserve, even if in strips, enough periosteum from each spine and lamina to make the deposition of bone therefrom fairly likely. As mentioned under General Considerations, practically the only practical justification for performing laminectomy, ordinarily recognized by the writer, is the doing of the operation subperiosteally. (If the subperiosteal method be not elected, the freeing of spines and laminæ is done in the same general way as in osteoplastic resection, except, in the present instance, that the chisel, with bevel towards the spines, is braced against the spinous processes as fulcra, and the soft parts are pried away from the spines and laminæ towards the transverse processes (or articular processes in the neck). The method of manipulating the chisel is shown at C, Fig. 10, but the special feature of removing the periosteum together with the soft parts is not shown in this illustration. As a result of the procedures just described, a path is cleared for the saw, extending onto the lamina next above and the one just below those to be removed.

(4) Division of Laminæ and Ligamenta Subflava.—Having removed the packing from the wound upon one side of the spines, its lip farther from the spinous processes is firmly retracted by two special retractors, thus exposing bared laminæ (Fig. 10, A, A). The saw, held with its edge at a right angle to the surface of the laminæ and somewhat nearer

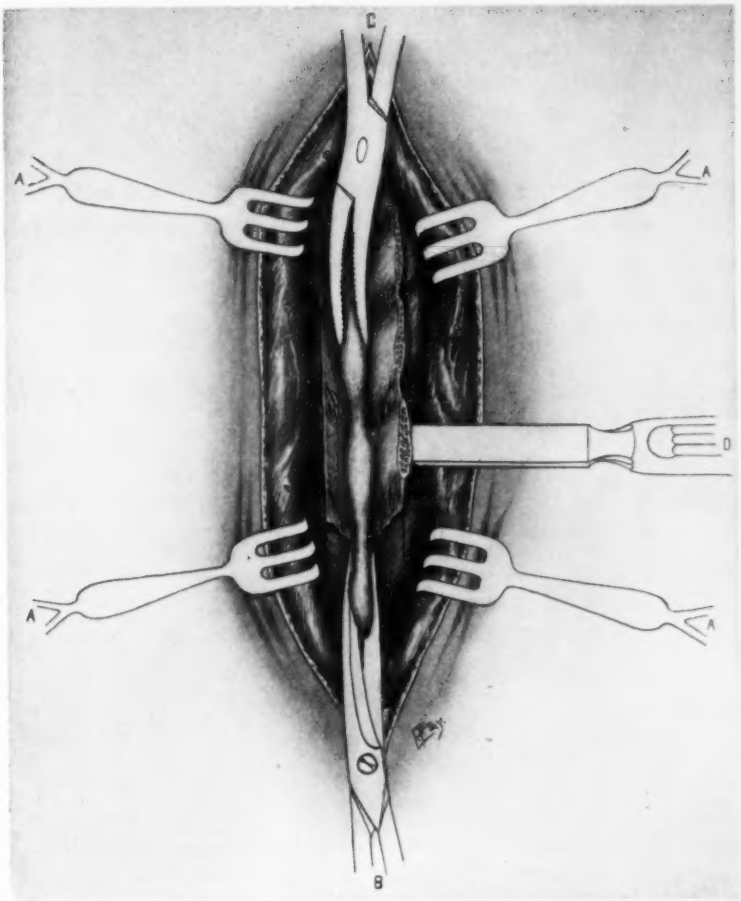

FIG. 11.—Laminectomy. A, A, A, A, Retractors separating edges of wound; B, curved scissors dividing interspinous and interlaminous ligaments; C, bone-holding forceps grasping spines and supraspinous ligaments, to aid in lifting out the excised area of bone; D, chisel, against transverse processes as fulcra, with edge in saw-cut, prying out the excised part. (Drawn from cadaveric operation.) *Note.*—The interlaminous ligament at the upper part of the wound should also be represented cut.

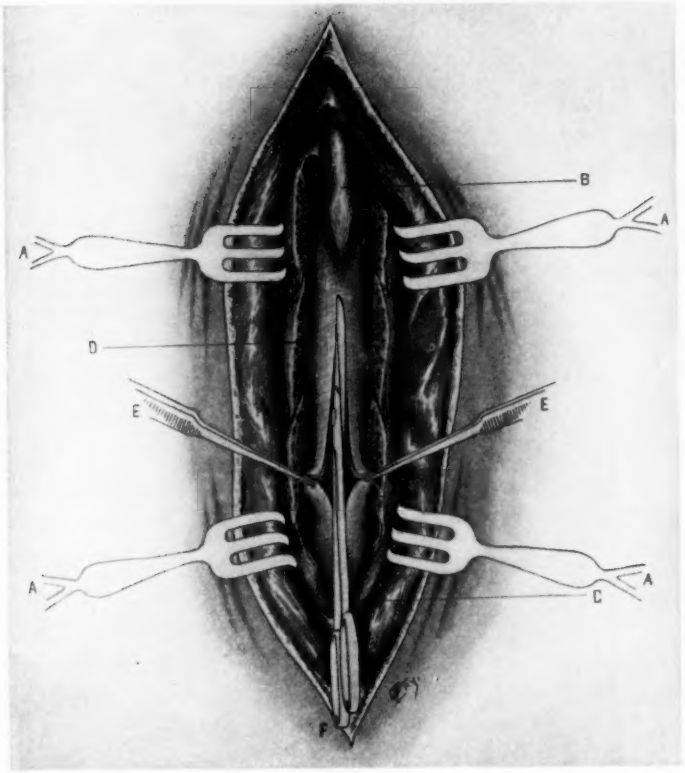

FIG. 12.—Laminectomy. A, A, A, A, Retractors holding apart margins of the wound; B, spinous process of vertebra above segment of spinal column removed; C, shelving laminæ of intact vertebra below; D, cut surface of laminæ; E, E, delicate forceps grasping membranes so as to form a transverse ridge; F, scissors in act of incising transverse ridge and continuation of membranes. (Drawn from cadaveric operation.)

the bases of the transverse processes (bases of the cervical articular processes) than the bases of the spines, is made to cut through the indicated laminæ, as well as through one-half of the lamina next above and next below those to be removed (Fig. 10, G). The course of the saw and the completion of the section should be determined as in the osteoplastic resection.

(5) Division of Supraspinous, Interspinous, and Interlaminous Ligaments.—The above ligaments between the spines and laminæ at the lower end of the section are divided with curved scissors, just as described in Osteoplastic Resection, and as illustrated in Fig. 11, B. In addition, the same ligaments are divided in the same manner at the upper end of the section. The segment of spines, laminæ, and ligaments is thus entirely isolated by the saw-cuts on either side and the division of the ligaments above and below. In Fig. 11 the saw-cuts and the division below are alone shown.

(6) Separation and Removal of Ligamento-osseous Section.—Having well retracted the margins of the wound (Fig. 11, A, A, A, A), and determined that the sections through bone and ligaments are complete, the segment thus limited is ready to be pried from its bed. While the spines and connecting ligaments are grasped by bone-holding forceps (Fig. 11, C), a chisel, with its bevelled edge away from the parts to be removed, and its blade braced against the transverse processes (or cervical articular processes) as fulcra, is made by depressing its handle, to lever out the mass from its bed, aided by moderate traction upon the forceps grasping the spines. In the act of its removal, the mass is given a downward direction, so as to dislodge the uppermost laminæ of the section from the laminæ and spinous process of the last intact vertebra above (Fig. 12, B).

(7) Freeing of the Cord from Extradural Areolar Tissue, and Control of Intraspinal Hæmorrhage.—These are accomplished exactly as in the Osteoplastic Operation described above, and partially illustrated in Fig. 8, G.

(8) Opening of the Membrane of the Cord.—This portion of the present operation is also accomplished in a manner

similar to that mentioned under the Osteoplastic Resection, and is pictured in Fig. 12, E, E, and F.

(9) Manner of Dealing with the Incised Membranes.—As in the Osteoplastic Operation.

(10) Deep Suturing of Muscles and Aponeuroses.—More care is here necessary than even in the osteoplastic resection. A large mass of tissue has been permanently removed, and the soft parts which were formerly in contact with the bones and ligaments which have just been removed are now to be brought into contact with each other and sutured together by deeply buried stout twenty-day chromic gut. In the apposition of these soft parts, whatever periosteum has been saved should be so manipulated as to be made to lie in as normal a relation as possible, so that whatever bony deposit occurs should take place as nearly as may be in the site of the missing laminæ and spines, and thus strengthen the spinal column. Interrupted sutures probably accomplish this object better than a continuous form of suturing.

(11) Skin and Fascial Suturing.—A median continuous, or interrupted, suture of silkworm gut, or silk, should be placed through skin and fascia.

(12) Provision for Drainage, when indicated.—What applies in principle in osteoplastic resection also applies here. When temporary intraspinal drainage, whether intra- or extradural, is indicated, drains are readily conducted from within outward to the skin surface, through openings left in the soft parts between omitted sutures.

(13) After-treatment.—Here, much more than in Osteoplastic Resection, may it be indicated not only to include some form of splint in the dressing immediately following the operation, but also the wearing of some form of spinal support for several weeks or months following the operation, until the spinal column has solidified through the deposit of bone by the periosteum, or otherwise.

(14) Comment.—The observations made under the Osteoplastic Operation also apply here.

A CASE OF CERVICAL RIB WITH SYMPTOMS RESEMBLING SUBCLAVIAN ANEURISM.[1]

BY JOHN B. MURPHY, M.D.,

OF CHICAGO.

THE existence of "surgical cervical rib" has been recognized by anatomists since Hunauld, in 1742, published his observation on this anomaly. True or complete cervical rib as described by Turuis (Mém. de l'Académie Royale des Sciences de Paris, 1742) has no surgical significance. The surgical literature, however, has not been very profuse on the topic, and the number of cases accurately described is comparatively small. A good review of the literature is given by Dr. Daniel N. Eisendrath (*American Medicine*, August 20, 1904), in which he abstracts practically all of the published cases (thirty-four).

The development of a cervical rib is either from the ossific centre of the transverse process of the sixth or seventh cervical vertebræ, or from a separate centre of ossification, articulating with the body and transverse processes of the cervical vertebræ in the same manner as the thoracic ribs. In the cases requiring surgical attention, it apparently develops from an individual ossific centre, as do the remainder of the ribs. Judging from the statistics of cases, cervical rib does not appear to develop until the patient is well into adult life; as in twenty-nine cases the average age was twenty-seven years. In eight other cases (age not given) it is mentioned that they were adults. The elongation and growth, therefore, of the transverse process or true rib would appear to correspond somewhat with the development or exfoliation of the wisdom teeth. Why the cervical process or rib should increase at this period of life is not known. While the transverse vertebral process has a separate centre of ossification, the process normally does not exceed

[1] Read before the Chicago Surgical Society, November, 1904.

five-eighths of an inch in length. In the development of a cervical rib from this process or from an independent centre of ossification, the rib not only increases in length but also in diameter as the distance from the spine increases, but the portion attached to the body of the vertebra remains the same diameter as the normal process (Fig. 1, A). Whether the growth is an addition to the tip from the cartilage that has been found capping it in many of the specimens, or whether it is an outward elongation from the vertebral body end, has not been definitely determined. It appears to me, however, on account of the increasing diameter of the rib, that the growth is by the deposit of additional bony material on the tip, in a manner similar to the growth of other long bones. In a number of cases, however, the attachment of scalenus medius or anticus to the rib is so far from the vertebra, that it would look as though the bone had elongated from its base and had been there from birth.

The length and size are well illustrated by the skiagram of Dr. Carl Beck's case. In my specimen the base of the rib measured three-eighths of an inch, while at the tip, where it curved downward to become attached to the first rib, it measured seven-eighths of an inch, and was flattened from above downward (Fig. 1, B). Cervical ribs exist normally in crocodiles (Eisendrath). In some cases the new-formed rib develops beneath and behind the branches of the brachial plexus and carries the nerve-trunks forward with the subclavian artery above it, so that the pulsation of the latter is the first conspicuous sign of trouble. Again, the end of the rib pressing on the nerves or artery and compressing them against the lower portion of the scalenus anticus (not against the margin of the first rib) causes in the former case severe pain and occasionally paralysis of the brachial plexus or one of its trunks, and in the latter an endarteritis or thrombosis, with suppression of the circulation and gangrene, or weakness of the vessel wall and aneurism (Fig. 4).

In looking over the clinical records of these cases, I was struck by the absence of œdema as a symptom, showing the

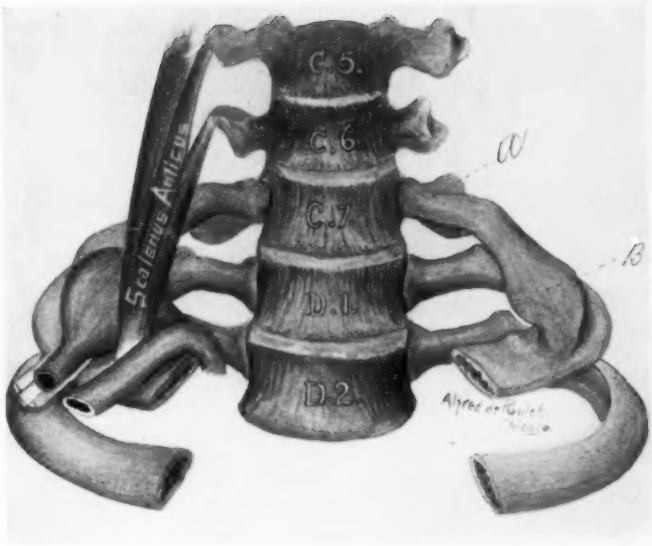

FIG. 1.—Cervical rib.

FIG. 2.—Case of Dr. Murphy.

FIG. 3.—Case of Dr. Beck.

Skiagrams of cervical ribs.

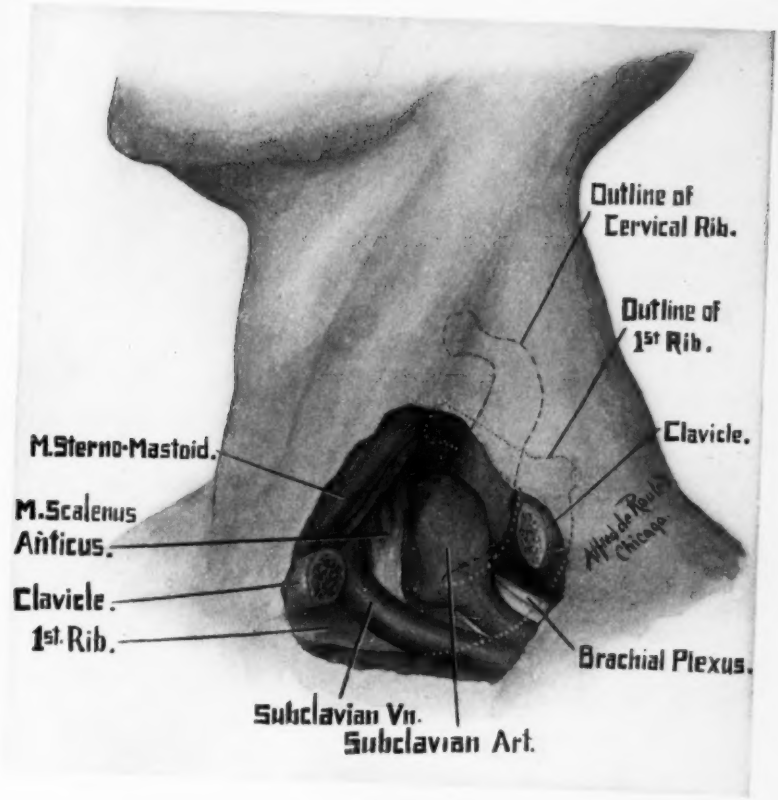

FIG. 4.—Cervical rib.

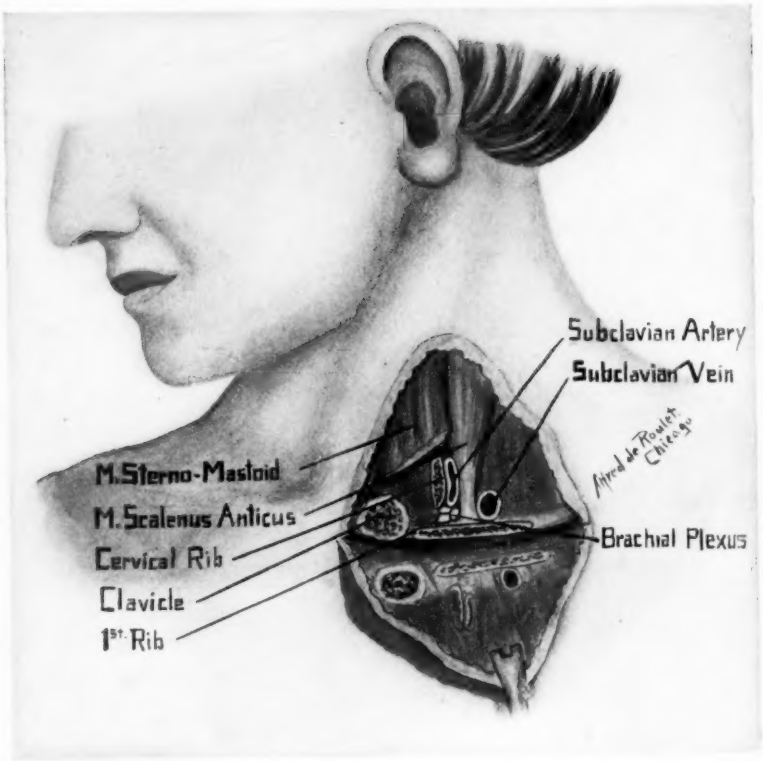

FIG. 5.—Cervical rib.

subclavian vein was not compressed, while the artery and nerves were severely compromised. This, I think, can be explained by the fact that the scalenus anticus is attached to the first rib and lies between the artery and vein, so the latter, situated in front of the muscle, has nothing to hold it firm for counterpressure. As the cervical rib advances forward, it carries the nerves and artery against the unyielding muscle and severely compresses them, while the vein, being anterior and external to the muscle, is never compressed (Fig. 5).

The small number of pulsating tumors recorded would indicate that aneurism was not common, and even those classed as such are doubtful in my mind. In our case the vessel spread out so as to cover almost the entire inch of rib surface, very much resembling an aneurism, but dissection showed there was very little dilatation of the vessel at that point.

The scalenus anticus is occasionally attached to the cervical rib, which seems to indicate its embryonal origin, but this may be only the lower attachment of the scalenus medius carried forward as the rib developed in an anterior direction. This would also tend to bind the artery and nerves beyond the possibility of escape from pressure and ultimate destruction if the rib continued to grow.

Gruber's classification is a good one:

A. The process-like projection scarcely extending beyond the transverse process.

B. The moderate degree extending an inch beyond the process with a free end or one attached to the first rib.

C. A thin quarter rib extending to the external border of the scalenus anticus with a free or attached end.

D. A complete rib with a sternocostal cartilage either individual or combined with the first rib.

The supernumerary rib exists on both sides in 67 per cent., or on one side in 33 per cent. of the cases in which they are found.

SYMPTOMATOLOGY.

The symptoms of cervical rib are entirely those of pressure and displacement involving the structures as follows:

A. Pressure on the nerve-trunks of the brachial plexus. (Paræsthesia, paralysis.)

B. Pressure on the subclavian artery. (Brachial ischæmia, aneurism, thrombosis, gangrene.)

C. Tumor formation in the supraclavicular triangle.

The symptoms produced by pressure on the nerve-trunks vary from slight tingling in the forearm and hand to complete paralysis in the area supplied by the compressed nerves. In the early manifestations, the symptoms are increased and diminished by changing the position of the arm. Elevation of the arm and shoulder relieves the nerve pressure, and the patients find that they rest more comfortably at night with the arm above the head, and that the boring neuralgic pains, as well as the numbness of fingers, hand, and forearm, are relieved by elevating the shoulder or supporting the body on the elbows. As the pressure becomes more severe and continued the paræsthesia and paresis are followed by anæsthesia and paralysis. The numbness and tingling announce the existence of pressure for months and even years before paralysis develops. The muscles of the forearm fatigue on very slight exertion; this may be due to the cellular ischæmia or nerve exhaustion. These cases are most frequently diagnosed as brachial neuralgia, neuritis, etc.

The change in the circulation is peculiar and striking and involves the arterial, never the venous, current. If the patient presses his hands firmly together there will be a rapid return of circulation to the "life-glow" on the normal side; while on the diseased side the hand remains blanched, wrinkled, and cold from a minute to a minute and a half, resembling the anteperiodic pallor of impending Raynaud's disease. This was one of the most striking symptoms in our case. Cold water felt many degrees colder on the affected than on the healthy side. There was no evidence of venous stasis. If

there had been, the "pallor" symptom would have been absent. Where the pressure had been great and continuous, the records of cases show that an obliterating endarteritis took place, and in two cases it was followed by gangrene. One can scarcely comprehend that a slow obliterating endarteritis from compression would produce a gangrene, as collateral circulation so rapidly develops; but a sudden and severe trauma of the artery in its exposed position for pressure might produce thrombosis with distant necrosis.

The sudden trauma of the artery could weaken its walls so that an aneurism would be produced, and this has undoubtedly occurred. But the diagnosis of aneurism should not be accepted in these cases except where a dissection and exposure of the artery have been made. Our case, on first sight, and, indeed, without the most careful examination, would have been diagnosed as aneurism, and one could scarcely convince himself that aneurism was not present on account of the broad pulsation as well as the lateral expansion signs. The broad surface was due, however, to the flattened condition of the subclavian artery over the wide terminus of the rib. This also permitted the lateral expansion with cardiac contraction. The bruit was present and extended in a downward direction, more marked with the shoulder depressed. With depression there is frequently an absent or diminished radial pulsation; when the shoulder is elevated the pulsation again becomes normal. In a number of the recorded cases radial and brachial pulsation were absent, and did not return after the relief of the pressure by removal of the rib.

The vein is not caught by the advanced end of the rib, as it is situated entirely anterior to the middle scalenus muscle, and therefore admits of great displacement in a forward direction without angulation or compression. There was no œdema of the arm or forearm in our case, nor did I find it mentioned as a symptom in any of the histories even where aneurism is recorded. This, as stated above, is probably due to the relation which the vein and the artery bear to the scalenus muscle. Even an aneurismal dilatation of the artery at that point would not press on the subclavian vein, but against

the anterior scalenus muscle, and, until that muscle had been destroyed by the aneurism, it could not compress the vein. Even then the vein would have ample opportunity to escape, as there would be no resisting body anterior to its inner side to act as a counter support. The relation of the scalenus muscle to the artery, nerve, and rib, and its effect as a counteracting force, has not up to this time been appreciated.

The following is a case of special interest because of the extreme severity of the symptoms before operation, and their prompt subsidence after the removal of the rib.

Patient, Mr. J. G., was admitted to Mercy Hospital, November 4, 1904. He was thirty-eight years of age and a farmer by occupation.

Present Illness.—About one and one-half years ago the patient first noticed a tingling sensation in the last phalanx of the left index-finger. This tingling and numbness were noticed especially when the hand was exposed to cold, and would disappear entirely if kept warm. The index-finger was the only part affected for six months after the onset, when the same trouble developed in the distal phalanx of the little finger. Symptoms continued about the same throughout the winter, and gradually subsided as the weather became warmer. During the summer the numbness and tingling were entirely absent, and did not reappear until two months ago, since which time all the fingers of the left hand have been affected. In addition to the disturbances of sensation, the patient now suffers severe pain in the palmar surface of the thumb and the anterior aspect of the wrist on the radial side. During the past few weeks this sharp lancinating pain has been so intense that he has been unable to sleep at night, and even large doses of morphine have failed to give relief. The left forearm and hand are always cold, and the muscular power is much weaker than before the onset of the trouble. At times the pain has radiated up the forearm to the elbow. When exposed to the cold, the forearm and hand become pale and the ends of the fingers ischæmic. To the left hand everything feels much colder than to the right. He has lost some flesh during the past few months, but the general health has been good. The patient has been treated for rheumatism and neuralgia without result.

Previous and Family History.—Negative. *Examination.*—Medium stature; well nourished; lungs negative; heart negative. One inch above the junction of the inner and middle thirds of the left clavicle a pulsating prominence is seen. Palpation of this prominence shows the pulsation is expansile, but greater in the horizontal direction than in the vertical. By deep pressure the pulsation of the tumor disappears, and the examining fingers then come in contact with a hard, unyielding mass, which can be traced backward to the lateral process of the seventh cervical vertebra. The pulsating tumor stands half an inch above the surrounding surface, and cannot be compressed to the level of the clavicle, which might be done were it an aneurism pure and simple. The brachial and radial pulsations are normal with the arm extended, but with the shoulder depressed there is a pronounced diminution in the arterial tension and force of the pulsation. There is a deep pallor of the hand and forearm, very pronounced after pressure on the hand. There is also a peculiar coldness of the forearm and hand.

Operation, November 9, 1904.—The shoulders were elevated on a small sand-bag, and the chin turned to the extreme right. An incision three inches long was made at the posterior border of the scalenus anticus muscle, almost parallel to it, but slanting a little backward. The subclavian artery was exposed and displaced forward, bringing the anterior end of the cervical rib into view. The rib was freed from its attachments back to the spine and divided. The brachial plexus was then displaced inward, rib slowly elevated, and the tissues gradually displaced until the anterior attachment to the first dorsal rib was in view. It was detached with the bone forceps, and the surface of the first rib smoothed off with a chisel. The artery was then carefully examined and seemed somewhat enlarged at the point of greatest pressure from the rib. The muscles were all replaced and fixed in position by catgut sutures. Primary wound healing occurred and the patient was discharged from the hospital, November 14. The pain had almost entirely subsided and the circulation was much improved.

Examination of patient, December 22, 1904, showed that the vessel had contracted to about its usual size, and the former elevated area had sunk to the normal level. Circulatory disturbances

in the hand and forearm had subsided, the pain disappeared, and the strength of the muscles was rapidly returning.

The greatest difficulty is in the diagnosis of the condition in its early manifestations; once it is suspected, it can usually be verified by palpation and a skiagram. The latter, however, in some cases is not so satisfactory as one would wish. All cases should be operated as soon as diagnosed.

The removal of the rib is not difficult or dangerous, if care be exercised in displacing the artery and nerves. The periosteum should be removed with the rib, otherwise it might be reproduced. I know of no reported case of reformation of the rib after removal.

CASES OF INTUSSUSCEPTION IN CHILDREN TREATED BY LAPAROTOMY.[1]

BY CHARLES HERBERT FAGGE,

OF LONDON,

Senior Surgeon to the Evelina Hospital for Sick Children.

THE eighteen cases of intussusception in children on which this paper is founded are all which have come under my care at either the Evelina Hospital for Sick Children (thirteen) or at Guy's Hospital (five).

I have not operated on any case as one of intussusception which has not proved to be intussusception, nor have I met with a case in which an intussusception has been overlooked.

So many writers of repute have for the past seven years urged the advantage of laparotomy over other methods of reduction, that its advisability must now be agreed upon; but well-recognized lines of treatment, especially if simple and non-operative, die hard, and so inflation will only be finally given up after many more successful laparotomies have been recorded.

Etiology.—Of the cases under one year, fourteen in all, ten were stated to have been entirely breast-fed, and all the babies were decidedly above the average of hospital patients in size and degree of nourishment.

Presence of a Tumor.—In sixteen of the eighteen cases a tumor was felt either through the abdominal wall or per rectum, and several times the value of bimanual examination, as suggested by Mr. Eve (*Clinical Journal*, 1899), was demonstrated; in fifteen of these sixteen cases diagnosis was easy and treatment was prompt. In one case (No. 16), on the history of some weeks' abdominal pain with occasional attacks of vomiting, a diagnosis of tuberculous peritonitis was made, the tumor being regarded as matted omentum and in-

[1] Read before the Clinical Society of London, December 9, 1904.

testines, and in consequence of this, operative interference was undertaken too late; this was probably a chronic intussusception, in which the acute exacerbations were caused by an increase of the invagination.

Both the cases in which no tumor was found ended fatally; in one (No. 4) the symptoms were not typical, and operation was delayed for twenty-four hours after her admission. Her symptoms before death were most peculiar, and were suggestive of some cerebral lesion rather than of any result of the intussusception; unfortunately, no post-mortem could be obtained. In the other case (No. 11), the abdominal distention and the position of the intussusception, which was enteric, no doubt were responsible for the failure to detect a tumor.

Yet, while a tumor was so frequently present, my cases well emphasize the variability of its position and the value of an examination under an anæsthetic in locating it. In fact, the observance of routine examination under an anæsthetic has several times led to the detection of a tumor in a case which might otherwise have been regarded as one of enteritis; unfortunately, in Case No. 4 this precaution was neglected.

Duration before Operation.—All writers agree that there is no exact relation between duration and ease of reducibility; but of those in which the time is given, all of less than forty-eight hours' duration were reducible, though with varying ease, which strikingly bears out Gibson's (ANNALS OF SURGERY, 1900) contention that after the second day the ease of reducibility markedly diminishes; for he reckons that on the first day 94 per cent., on the second day 83 per cent., and on the third day 61 per cent., are reducible.

Variety of Intussusception.—After Mr. Corner's exhaustive paper (ANNALS OF SURGERY, 1903), and as Mr. Wallace has fully dealt with this part of the subject in his paper, I do not propose to say much about the varieties of intussusception met with. It seems now probable that single ileocæcal intussusceptions are not as common as earlier writers—Sargent (*St. Thomas's Hospital Reports*, 1900) and Eccles

(*St. Bartholomew's Hospital Reports*)—considered; yet, though I have since my first operation carefully looked for double intussusceptions, ten, at least, of my eighteen cases were of the single ileocæcal type. The eleventh single intussusception was enteric (No. 11), and was of interest in that the ileum at the apex of the intussusception was so much narrowed as to suggest the possibility of a congenital stricture at that spot having given rise to the intussusception. A second point worth mention in this case was a persistent Meckel's diverticulum: this was some distance above the intussusception and clearly had never been involved.

I can only record seven double intussusceptions: colic ileocæcal, 3; ileocolic-colic, 2; enteric-ileocæcal, 2.

My early acquaintance in April, 1900 (Case No. 2), with the cæcal variety of Mr. Eve (*Clinical Journal*, 1899), described by Mr. Corner as colic ileocæcal, led me to look for this form again, but only two other examples (Nos. 14 and 17) were met with, making 16.6 per cent. of the eighteen cases.

In Case No. 7 there was possibly a triple intussusception, for the ileum was prolapsed into or through the ileocæcal valve, and there was a well-marked and apparently independent invagination of the caput coli some distance to the right of the valve, so that this may be colic ileocolic-colic, and not ileocolic-colic, as I have regarded it in my list.

I do not attach great value to a minute division of intussusceptions into many varieties, and at an operation completed as rapidly as possible it is obviously most difficult to distinguish between forms so nearly related as ileocolic-colic and enteric-ileocæcal. (Corner.)

Treatment and Technique.—In seventeen of my cases primary laparotomy was undertaken at the earliest possible moment; in the eighteenth (No. 9), inflation had been twice tried and had failed before I saw the case. Except in cases 11 and 16 my incision was always made on the right side of the middle line, with the centre at or below the level of the umbilicus; in the majority it was through the right semilunar line; but recently I have cut vertically over the right

rectus, separating its fibres, thinking that by this means a firmer scar might be obtained.

I have not made use of the combined method of inflation with laparotomy (Kellock), which in my opinion, besides the time necessary for its performance, has the great disadvantage that it increases the intra-abdominal contents, and therefore will militate against the replacement of the already distended intestines within the abdomen. I have found that a second assistant's finger introduced per rectum promptly and gently reduces the intussusception usually as high as the iliac colon, where it can be easily dealt with by the operator from the abdominal cavity.

Until the reduction has reached the ascending colon it is carried out partly out of sight; then the intussusception is delivered from the abdomen, and the remainder of the procedure carefully watched.

Escape of the intestines during the manipulation of the intussusception is, I feel sure, to be avoided whenever possible, and, in fact, often the chief difficulty is experienced and much loss of time is occasioned in returning the escaped bowel within the peritoneal cavity; further, I feel sure that the dragging of the dependent intestines upon the mesenteric plexuses increases shock. When this does happen and the bowel is much distended, I have found it most useful for the assistant to strongly lift up and separate the two edges of the wound with Spencer Wells's forceps, when the bowel can be paid back coil by coil into the abdomen.

Unless the condition of the patient was extreme, the abdominal wall was always united by three layers of sutures, silk in the early cases and catgut recently being used for the buried sutures.

Results.—Six cases (Nos. 3, 10, 11, 15, 16, and 18) died between four and twenty hours after the operation from shock and toxæmia; of these in Nos. 11, 15, 16, and 18 this was clearly due to the resection of the bowel. One (No. 10) was so ill that nothing more than the formation of an artificial anus could be attempted.

As there was no post-mortem in Case 4, I cannot suggest the cause of death on the fourth day; when the abdomen was opened a second time, it was thought that the intestines might not have recovered from the strangulation, but everything was found to be perfectly healthy, and there was no obvious cause for her condition.

I do not propose with my small number of cases to dwell on statistics; my immediate results show a mortality of 39 per cent. (seven deaths in eighteen cases); if we include two other babies (Cases 5 and 6) who were readmitted within a few days of their discharge, and whose death was indirectly a result of the intussusception, the mortality increases to 50 per cent.; both these died twenty-three days after the laparotomy, which could have had no relation to the ultimate result.

I have perhaps been unfortunate in the large proportion of irreducible and gangrenous intussusceptions (five cases) that have come under my notice, for, excluding these, the mortality of two out of thirteen laparotomies works out at 15.4 per cent.

I am sure everybody will agree that no mechanical means alone could reduce an intussusception found to be irreducible or gangrenous at a laparotomy; and yet I know of no statistics embracing a large number of cases treated alone by inflation which give a mortality even as low as 50 per cent.

In the two cases (Nos. 5 and 6) who were readmitted for diarrhœa, it is probable that the intestines, though easily reduced, did not return to their normal condition. In support of this idea, the notes of the post-mortem on No. 5 are most interesting, for here the reduction was peculiarly easy and the intestines at the time of operation apparently only slightly strangulated. It is therefore probable that the same result would have followed reduction by mechanical means, which suggests that intussusception may be followed by remote as well as immediate risks, and that the recovery of the child from his acute illness may be more apparent than real. It would be interesting to know whether the ultimate results in

No.	Name.	Sex.	Age.	Date.	Feeding.	Symptoms.	Position of Tumor.	Time of Operation after Onset
1	L. C.	F.	3½ months	Apl., 1900	Breast	Sudden onset, crying out and vomiting. Blood passed ten hours after onset. Tumor felt in abdomen.	Right hypochondrium.	21 hours
2	C. W.	F.	3½ months	Apl., 1900	Breast	Sudden onset, screaming, refused food, sick. Blood six hours after onset. Abdomen rigid and distended. Nil on R. E., bnt tumor felt bimanually under anæsthetic.	Right inguinal region, just above pelvic brim.	45 hours
3	A. E.	M.	5 months.	Dec., 1900	Breast	Sudden onset, screaming. Blood passed five hours after onset, vomiting. Tumor felt, and on R. E. apex of intussusception 1½ inches from anus.	Left iliac region.	33½ hours
4	L. R.	F.	9 years.	Mar., 1900		Vomiting, pain under right rectus; bowels open, no blood. Sent in diagnosed as intussusception. Nothing found even under anæsthetic, very sick.	No tumor.	3 days
5	E. N.	M.	3 months.	July, 1901	Breast	Sudden onset, crying, and soon passed blood and mucus, vomited. Tumor felt. R. E. nil.	Right lumbar region.	15 hours
6	M. G.	F.	6 months.	Sept., 1901	Breast	Sudden onset, vomiting, crying, passed blood and mucus. Tumor felt. R. E. revealed nil, but blood and mucus were on finger; nothing on bimanual examination.	Right lumbar and hypochondriac regions.	29 hours
7	D. H.	M.	8 months.	Jan., 1902	Breast	Strained and passed normal stool, when "prolapse" came down, which doctor reduced, after which blood and mucus were passed and "prolapse" came down again.	Projecting from anus.	30 hours
8	W. M.	M.	6 months.	June, 1902	Not stated	Blood passed, vomiting, and tumor felt.	Not stated.	....
9	J. D.	M.	9 months.	Aug., 1902	Not stated	Sudden onset, vomiting, blood passed, tumor felt.	Umbilical region.	9
10	A. G.	M.	3 months.	Aug., 1902	Breast	Sudden collapse, vomiting, blood and slime passed, tumor felt. On R. E. no tumor felt, but blood on finger.	Left side, mainly in left iliac region.	53
11	R. B.	M.	15 years.	Sept., 1902	....	Pain in abdomen, vomiting, B. O. only once since onset (five days), and then blood was passed. Some distention.	No tumor.	5 days
12	A. D.	M.	11 months.	Dec., 1902	Breast and other food	Sudden onset of vomiting. tumor easily felt. R. E. disclosed apex 1½ inches from anus.	Left side from left hypochondrium to left iliac fossa	9½ hours
13	C. R.	F.	5 months.	Feb., 1904	Breast	Sudden onset, crying, straining, persistent vomiting, passage of blood and slime. No tumor felt until anæsthetic given, when a transverse tumor was found.	Umbilical region.	32½ hours
14	E.C.M.	M.	4½ months	Mar., 1904	Not stated	Crying, passed mucus and blood, tumor felt under anæsthetic.	Not stated.	5¾ hours
15	B. M.	M.	3 years.	Apl., 1904	....	.....	.....	....
16	E. B.	F.	9½ years.	Apl., 1904	....	Has been ill for six weeks with abdominal pains and vomiting, was treated at another hospital, and admitted to Evelina three weeks before operation. Mass felt around umbilicus. There was only occasional vomiting until three days before operation, after which it was frequent. Tumor unaltered. Abdominal pain almost constant. Bowels irregular. No blood passed.	Umbilical.	3 weeks 3 days
17	C.E.U.	M.	11 months	June, 1904	Breast	Sudden vomiting, much crying, with pain. Tumor felt. On R. E. nothing found.	Right hypochondrium and epigastrium.	8½ hours
18	E. S.	M.	8 months.	Dec., 1904	Breast	Passage of blood. Severe abdominal pain; no vomiting. Treated three weeks for dysentery.	Not felt in abdomen, easily felt per rectum.	3 weeks

CASES, 18. Males, 12; Females, 6. { Ileocæcal, 10; Colic—ileocæcal, 3; Enteric—ileocæcal, 2; Ileocolic—colic, ? 2; Enteric, 1.

Nature.	ure.	Duration of Operation.	Result.	Remarks.	Ultimate Result.
Ileocæcal	2 layers	40 minutes	Discharged	Reduction difficult. Peritoneum torn in several places and sutured with silk. Child was very ill, with vomiting for thirty hours after operation.	September 1, 1901. I opened a post-pharyngeal abscess. December, 1904, quite well, scar firm.
Colic—ileocæcal	1 layer	Not stated	Discharged	Reduction very easy. Great difficulty in returning intestines which had escaped.	
Ileocæcal	1 layer	35 minutes	Died	Reduction extremely difficult. Peritoneum and muscular coat much torn; sutured. Intestines returned with difficulty. Death twenty hours after operation.	No post-mortem.
Ileocæcal	3 layers	Not stated	Died	Child was not admitted until two days after onset; and when seen next day I diagnosed "obstruction." Intussusception was found with difficulty; easily reduced. Much improved after operation, but on fourth day became comatose and moaned. I again opened abdomen and found nothing.	No post-mortem.
Ileocæcal	3 layers	About 20 minutes	Discharged	Reduction easy. Child did well for eight days, when diarrhœa began; this improved, and he was discharged to be fed by mother, but he was brought back next day very ill and died twenty-four days after operation.	Post-mortem.—No peritonitis; cæcum, ascending colon, and end of ileum grayish and very friable and much collapsed. Catarrhal enteritis.
Enteric—ileocæcal	3 layers	18 minutes	Discharged apparently well.	Was not admitted until twenty-four hours after onset. Reduction easy. Last two inches of ileum reduced last.	Readmitted next day with diarrhœa and vomiting, and died eleven days later. No post-mortem.
? Ileocæcal —colic ? Colic—ileocolic colic	3 layers	22 minutes	Discharged	Reduction very easy, after all the part in rectum had been reduced by a finger within rectum.	December, 1904, quite well, scar firm.
Ileocæcal	....	.....	Discharged	Report missing. Notes from observers.	Readmitted in September, 1902, and died of bronchopneumonia; cæcal region normal.
Ileocæcal	3 layers	15 minutes	Discharged	Two attempts at inflation with milk failed to cause disappearance of tumor. Reduction easy.	
Unreduced; at P. M. found to be ileocæcal	Not sewn up	Under 20 minutes	Died	Intussusception could not be reduced, so a Paul's tube was tied into ileum and the intussusception left outside.	Died five hours later. At the post-mortem Dr. French could not reduce the intussusception.
Enteric	3 layers	45 minutes	Died	Peritonitis. Resection of eighteen inches of small intestine, which was gangrenous and perforated, end-to-end anastomosis with simple suture. Meckel's diverticulum present, not involved.	Death four hours after operation. Resection six inches from ileocæcal valve.
Ileocæcal	3 layers	35 minutes	Discharged	Reduction difficult and prolonged.	December, 1904, is delicate.
Colic—ileocæcal	3 layers	17 minutes	Discharged	Reduction easy. Well-marked cæcal dimple.	December, 1904, seems well, but still passes blood. Scar firm.
Ileocæcal	3 layers	Under 30 minutes	Discharged	Reduction easy; suture of abdominal wall took a long time because of tendency of bowels to prolapse.	
Enteric—ileocæcal	3 layers	About 45 minutes	Died	Irreducible. Enteric intussusception resected and gut united by end-to-end anastomosis with simple suture.	Died six hours later. Post-mortem, early peritonitis.
? Ileocolic—colic ? Ileocæcal	3 layers	Under 60 minutes	Died	The case was regarded as tuberculous peritonitis; when I saw her just before operating, she had pulse 160, abdominal facies, was very restless, constantly sick, abdomen extremely tender and rigid; indicating "obstruction." The intussusception extended into descending colon, and the part in the ascending colon could not be reduced, so it was resected and end-to-end anastomosis done.	Died five and a half hours after operation. Post-mortem, no peritonitis.
Colic—ileocæcal	3 layers	20 minutes	Discharged	Reduction easy. Rapid recovery, but on thirteenth day wound burst and small intestine and omentum prolapsed. Under anæsthetic, gut returned and wound resutured in one layer.	Was readmitted with whooping-cough, of which he died, September, 1904.
Ileocæcal	3 layers	45 minutes	Died	Abdomen very much distended and contained turbid fluid; last three inches could not be reduced and ensheathing layer torn, so this was opened and tumor exposed and removed. The gut was joined by Maunsell's end-to-end anastomosis.	He died five hours later. Post-mortem, early peritonitis.

Died, 7. Mortality, 39 per cent.; or, excluding irreducible cases, 15.4 per cent.
Under one year of age: Mortality, 21.4 per cent.; excluding irreducible cases, mortality, 8.3 per cent.

a large number of cases treated by different methods confirm this suspicion of vulnerability in children who have recently suffered from intussusception.

May I venture to suggest for discussion the treatment of irreducible intussusception?

Here I think we must separate simple irreducible cases from those which, besides being irreducible, are also gangrenous. Thinking over my five irreducible cases (Nos. 10, 11, 15, 16, and 18), I am in agreement with Gibson (ANNALS OF SURGERY, 1900) in decidedly preferring resection in gangrenous cases to the formation of an artificial anus, for, as Gibson points out, the latter does not remove the infective intestine.

In non-septic irreducible cases, either an artificial anus or a longitudinal division of the ensheathing and returning layers may be undertaken, and I intend in my next case to adopt the latter course, following it, if necessary, by a modified resection.

In the four cases with gangrenous bowel resection was carried out in three (Nos. 11, 15, and 16) by enterectomy between Lane's clamps and end-to-end union by simple suture in two layers, the inner passing through all the coats and the outer through the peritoneal and muscular coats only. In the eighteenth case the apex of the intussusception was exposed by incision through the ensheathing layer and cut off, the cut ends of the intestine being united by Maunsell's method.

Gibson (*loc. cit.*) quotes sixty-one cases of irreducible or gangrenous intussusceptions of which forty-nine died, and the fact that there was only one resection for a gangrenous intussusception among the twelve recoveries is a strong argument for inquiry as to the best line of treatment in these cases.

A SERIES OF CASES OF INTUSSUSCEPTION IN CHILDHOOD.[1]

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THIS series is made up of twenty cases,—twelve were males and eight were females. They were treated at St. Thomas's Hospital and at the East London Hospital for Children, between the years 1898 and 1904. The cases were consecutive, and include all that have passed through my hands. The results are good, I think, but they only represent the improvement that has taken place at all hospitals of late years, due to the now almost universal custom of speedy operative interference, which is largely due to the efforts of Mr. E. A. Barker.

Nature of the Intussusception.—Of the twenty cases, nineteen were enterocolic, that is, involved both the large and small guts; the remaining case was of the colic variety. Of the former class ten were single and nine were double intussusceptions. The single intussusceptions were of the ordinary ileocæcal type. It is, however, possible that in two the starting-point was an invagination of the outer wall of the cæcum, since, after the reduction of the tumor, this part of the cæcal wall remained invaginated, and was with difficulty made to resume its normal shape.

Of the double tumors there were four cases of the enteric-ileocæcal (iliaca-ileocolica) and five cases of the ileocolic-ileocæcal (ileocolic-colic) varieties.

These facts can be tabulated as follows:

Number of cases	20
Small and large gut involved	19
Large gut involved	1

[1] Read before the Clinical Society of London, December 9, 1904.

(1) Ileocæcal	10,	or 50 per cent.
(2) Ileocolic-ileocæcal (ileocolic-colic)	5,	or 25 per cent.
(3) Enteric-ileocæcal (iliaca-ileocolica)	4,	or 20 per cent.
(4) Colic	1,	or 5 per cent.
	20,	or 100 per cent.

The diagnosis of the enteric-ileocæcal was made if an enteric intussusception remained after the large gut had been entirely reduced.

An ileocolic-ileocæcal (ileocolic-colic) intussusception was diagnosed, if after the reappearance of the cæcum and the appendix there was still small intestine prolapsed through the valve.

On account of the frequent occurrence of double intussusceptions, Mr. E. M. Corner, in a very interesting paper (ANNALS OF SURGERY, May, 1903), expressed his opinion that the accepted ideas as to the comparative frequency of the different forms of intussusception must undergo a modification.

Mr. Corner has prepared a table showing what he believes to be the relative frequency of the different varieties, and has proposed a nomenclature for the double intussusceptions.

My own series certainly bear out the contention that double tumors are more frequent than has hitherto been considered to be the case. It is, however, open to doubt that a useful purpose is served by a complicated classification.

If we take the case of those intussusceptions that originate near the ileocæcal valve, we find that they are all of the ileocæcal type, and that the main characteristics of the intussusceptions are identical as regards their appearance and the structures forming their walls; and it is only after the reduction of the main tumor that the presence of a second intussusception allows a differential diagnosis to be made.

The ileocæcal region of the intestinal tract is a complicated one, and, having attracted much attention, is more richly endowed with names than any other region of the same length.

With a little ingenuity a very extensive nomenclature can be made out for intussusceptions arising in the neighborhood,

and this will be still further increased by the frequent occurrence of double tumors. In the latter case the names to be assigned to the different forms will vary with the views of the individual making the classification.

For instance, should an intussusception that starts as a prolapse of the small gut through the ileocæcal valve be termed ileocolic-colic or ileocolic-ileocæcal, or suppose an enteric intussusception becomes impacted in the valve, and then both valve and enteric intussusception become invaginated into the colon, is the resulting tumor to be called enteric-ileocæcal or enteric-ileocolic-ileocæcal or enteric-ileocolic-ileocæcal colic or enteric-ileocæcal colic? Such compound names are made up on the assumption that the last intussusception to be reduced is the first to be formed, but I do not know if there is any proof that this is the case.

Even in the case of single tumors there are difficulties, thus: What is the proper designation of an intussusception that starts in the caput coli and eventually involves the small gut? Is it cæco-colic or cæco-ileocæcal or colic-ileocæcal? (Corner.) Again, suppose the appendix is found to be invaginated after the rest of the intussusception has been reduced, how is such a tumor to be named? In fact, any attempt to name all possible forms of intussusception can only lead to confusion.

I would suggest that, instead of complicating the nomenclature, it would be better to simplify it, and call all intussusceptions involving large and small gut entero-colic, and indicate whether they are double and where they started.

Although the ileocæcal variety is rarer than the existing tables make out, my own series seems to show that it is still frequently to be met with as a single intussusception.

The observations on which this paper is founded were made with the suspicion that compound tumors were fairly common, and I was careful to observe the state of the bowel at the end of the reduction.

In this series there occurred no example of an enteric or simple ileocolic intussusception. The latter, when it was met

with, was only found after the main intussusception had been reduced. An ileocolic intussusception must always be of small extent, since the amount of small gut prolapsed through the ileocæcal valve must be limited by the length of the mesentery of the small gut, and it therefore stands to reason that the length of small gut involved cannot be more than double the length of the mesentery; as a matter of fact, it seems to very rarely reach even this extent.

In this variety the increase in length is made at the expense of the entering tube; in this particular, and in that the most advanced portion is not constant, it differs from other intussusceptions, and is really more of the nature of a prolapse than a genuine intussusception.

Diagnosis.—This, as a rule, is sufficiently easy, since the occurrence of the usual history and symptoms with the presence of a tumor in the abdomen or rectum renders the diagnosis practically certain. It is indeed on the presence of the tumor that we must rely to differentiate this disease from some forms of enteritis. My own experience has led me to the belief that a tumor can in by far the greater number of cases be felt without difficulty, and should there be any doubt, an anæsthetic will at once settle the question. The importance of giving an anæsthetic when in doubt, instead of waiting, has been insisted upon by Mr. F. C. Wallis (*Lancet*, June 11, 1904), and I should like to add my testimony to his. On the other hand, I have known a tumor confuse the diagnosis in two cases under my care. In one the tumor turned out to be a mass of glands near the cæcum, and in the other the tumor was a long dependent lobe of the liver.

Causation.—Of the sixteen cases in which a definite statement is made, there was only a history of improper feeding in three instances. In every instance the patients were well-nourished, healthy children; they were not rhachitic, nor did their appearance suggest improper feeding. Indeed, it seems probable that the success of the operative treatment may largely depend on the fact that the general good health of the

patients enables them to combat successfully the shock of abdominal section.

This series, therefore, throws no light, except in a negative character, on the causation of intussusception.

Duration before Operation.—The extremes were seven hours and four days.

With the exception of two cases in which resection was performed, and in which there was a possibility respectively of a fourteen and twenty-one days' history, was there any relation between the duration of the symptoms and the difficulty of reduction; neither could I trace any relation between the nature of the intussusception and the facility or otherwise of the reduction.

Treatment.—This may now be stated to be primary abdominal section. Inflation, except as an auxiliary measure to reduce the tumor out of the pelvis, as advised by Mr. Kellock, is now abandoned. If further proof of the inefficiency of inflation were needed, Case 6 would furnish it. In this case, inflation was tried three times, and on each occasion the tumor reappeared.

The site of the incision is open to discussion.

If the intussusception has reached the pelvis, no one incision will be the most convenient at all stages of its reduction. The site of the abdominal opening must therefore be largely determined by the fact that it is necessary to perform the last stages of reduction with the tumor in sight. The incision adopted in this series was one through the right rectus muscle, its length was about three inches, and its centre lay three-fourths of an inch to the right and below the umbilicus.

This situation lies nearly at the centre of the circle traced by an intussusception, but is sufficiently near the normal site of the cæcum to permit the tumor to be easily brought out at the end of reduction, if not during the whole course. I have found that it is often extremely difficult to keep the tumor in sight while the reduction is being effected at the splenic and hepatic flexion of the colon.

The following was the technique adopted in this series:

Directly the peritoneum was opened, the end of the tumor was brought out of the wound and the reduction accomplished under the eye. If the tumor lay in the pelvis, it was necessary occasionally to reduce a few inches within the abdomen until the lower end came easily under the wound.

No attempt was made to retain the intestines in the abdomen. If they escaped,—and they did so in the majority of cases,—they were simply covered up with a warm sponge. In fact, the intestines were not the object of any special solicitude. The point aimed at was rapidity of operation. The average time taken in eleven cases in which a note was made was fourteen minutes; in this list are included a resection of gut and the excision of a gangrenous appendix.

Suture.—The incision through the rectus muscle facilitates rapid suture, since the layers are quite distinct in this situation.

The following were the methods adopted: Suture in one layer, 4; suture in three layers, 9; suture through all layers and separate suture of anterior rectus sheath, 6; not stated, 1. Total, 20.

The material used was, as a rule, fine silkworm gut, and in a few cases fine silk.

Of the nine cases sutured in layers, two burst open and required resuture; one of these ended fatally. The case that recovered was resutured by Mr. Llewellyn at the East London Hospital for Children. This want of union in young children is a factor that must be reckoned with, and is best avoided, I think, by using deep sutures through all the coats and separate suture of the anterior rectus sheath.

The cause of the reopening of the wound is the failure of reaction and the sloughing of the delicate tissues in the embrace of the sutures, when only thin layers are included.

I have within the last six months seen the scar in all the successful cases, and in every instance they were perfectly sound. This fact tends to show that, as regards ultimate results, the method of suture is immaterial.

Results of the Operations.—The time that elapsed between

the operation and the advent of death showed that the fatal result was not directly due to the effects of the operation.

The intervals were: (1) six days; (2) six days; (3) ten days; (4) few hours.

The causes of death were: (1) bursting open of the wound; (2) thrombosis of cerebral veins (resection case); (3) gangrene of cæcum and inanition; (4) shock; extensive resection of nearly the whole of the large gut.

Mr. Barker, who has had great experience of these cases, lays special stress on reducing the intussusception within the abdomen in order to reduce shock. This series seems to show that after all too much stress can be laid on this point, as no attempt was made to keep the intestines in if they insisted in coming out. It seems to me that much valuable time may thus be lost. The two methods, at any rate, show equally good results.

The Appendix.—One interesting point in the series was the difference in the appearance of the appendix. In five instances this organ was normal in color, though the intestine in its immediate neighborhood was black from congestion. It did not appear that the variety of intussusception had any relation to the state of this organ.

After-history.—With three exceptions, I have traced all the successful cases.

In all the scars are sound, no matter the method employed. In all the children are healthy and well, except in one case, where attacks of vomiting occurred at times. This case succumbed to acute strangulation by a band.

Case.—A. W. B. suffered from attacks of vomiting at times, for which he was admitted to hospital. With simple treatment the attacks subsided, and, as nothing abnormal was noted in the abdomen, no operative measures were proposed. In June, 1904, the child (then four years old) was admitted for acute intestinal obstruction. The obstruction, due to a band passing from the mesentery to the bowel wall, was relieved, but death ensued in forty-eight hours.

It is remarkable that a child aged only sixteen weeks and extremely ill should have survived a cœliotomy for the reduction of an intussusception, while at the age of four it should have succumbed to a like operation for the relief of acute obstruction by a band. It certainly serves to show how very grave a disease is acute obstruction by a band. This fact has been emphasized by Mr. Makins, who believes that but little improvement in the mortality of this disease has taken place of late years.

The Fall in the Mortality.—In my series there were twenty cases and four deaths, which give a mortality of 20 per cent. If the cases in which a resection was performed were excluded, the mortality falls to 11.11 per cent.

Taking the cases under one year of age, there were sixteen, with three deaths; mortality, 18.75 per cent.; or, excluding the case of resection, 13.33 per cent.

From Sargent's tables (*St. Thomas's Hospital Reports*, 1900), I find that from 1892 to 1901 there were sixty-two cases of intussusception in children under one year, which were treated by cœliotomy (inflation has been tried in some). There were thirty-eight deaths, or a mortality of 61.29 per cent. If all the cases under one year are taken into account, the numbers are seventy-two cases, and the mortality 61.11 per cent.

Barker (*Clinical Society's Transactions*, Vol. xxxi) gives the following figures from cases that occurred in University College Hospital from 1892 to 1896 (both years included): Under one year, fifteen cases; mortality, 40 per cent.; under one year, treated by cœliotomy (either primary or after inflation), fourteen cases; mortality, 42.86 per cent. Of cases treated by Barker himself, there were twenty-five, with a mortality of 28 per cent.

Mr. D'Arcy Power in 1898 stated that the mortality of cases (not necessarily under one year) operated on within forty-eight hours of the onset was 22 per cent., and expresses the belief that this would be lower in the near future. The improvement that has taken place is well shown in the follow-

ing table of cases treated at St. Thomas's Hospital (Sargent). All cases under one year (no matter how treated):

	Died.	Cured.	
1892	3	1	
1893	2	0	
1894	1	1	
1895	4	1	
1896	5	1	
1897	6	1	
1898	4	2	Cœliotomy (primary) as a routine measure.
1899	6	8	
1900	6	6	
1901	7	7	
	44	28	

Total, 74; mortality, 61.11 per cent.

In the last three of the above years there were forty cases with nineteen deaths, or a mortality of 47.5 per cent.

Intussusception, like appendicitis, seems to be on the increase, at any rate as regards those admitted to hospital.

The following figures are from St. Thomas's:

Year. (Periods of five years.)	Number of Cases of Intussusception.	Total Number of Admissions to St. Thomas's Hospital.
1879–1883	10	20,016
1884–1888	10	23,103
1889–1893	12	25,338
1894–1898	40	29,493
1899–1903	90	31,547

From this it will be seen that the number of intussusceptions has increased tenfold, while the total admissions, all departments included, have only increased by one-half. The increase is therefore actual and relative.

In conclusion, and as showing well the strides that have been made in treatment, I cannot do better than quote one or two passages from a book * written by a great authority on this subject in 1884.

* Some points in the Anatomy, Pathology, and Surgery of Intussusception.

TABLE OF TWENTY CASES OF

No.	Name.	Sex.	Age.	Duration of Operation.	Situation of Tumor.	Method of Feeding.	Nature of Intussusception.	Method of Suture.
1	A.W.B.	M.	16 weeks.	7 hours.	Left iliac fossa.	Not stated.	Ileocæcal.	1 layer.
2	A. S.	M.	5 months.	10 hours.	Umbilical.	"No improper food."	Enteric—ileocæcal.	Not stated.
3	F. W.	M.	20 weeks.	2 days.	Present; situation not stated.	Not stated.	Ileocæcal.	3 layers.
4	F. C.	F.	33 months.	6 days. ? 3 weeks.	Left iliac fossa, also protruded from anus.	Nothing wrong noted.	Ileocæcal.	1 layer.
5	J. B.	M.	17 months.	3 days.	Left loin, also felt in rectum.	Breast, also bread and butter.	Ileocæcal.	Deep and rectus sheath sutures.
6	L. L.	F.	7 months.	30 hours.	Left iliac fossa.	Breast, occasional bread and butter.	Enteric—ileocæcal.	Deep and ant. rectus sheath sutures.
7	H. R.	M.	8 months.	4 days.	Right hypochondrium.	Breast.	Ileocæcal.	3 layers with 1 deep suture.
8	A. H.	F.	3 months.	36 hours.	Left lumbar, felt in rectum.	Breast.	Ileocæcal.	3 layers with 2 deep sutures
9	C. A.	F.	6 months.	2 days.	Left loin, felt in rectum.	Breast and bottle.	Ileocæcal.	Deep and ant. rectus sheath sutures.
10	J. R.	M.	5 months.	26 hours.	Splenic region.	Breast.	Enteric—ileocæcal.	3 layers and 1 deep suture.
11	S. B.	M.	5 months.	18 hours.	Umbilical region.	Breast; had a piece of mackerel.	Ileocolic—ileocæcal.	3 layers.
12	E. A.	F.	5 months.	18 hours.	Umbilical region.	Breast.	Ileocolic—ileocæcal.	3 layers.
13	P. S.	F.	21 months.	2 days.	Splenic region.	Not stated.	Colic.	3 layers.
14	W. F.	M.	4 months.	12 hours.	Splenic region.	Breast.	Ileocolic—ileocæcal.	3 layers.
15	S. P.	F.	3 months.	28 hours.	Splenic region.	Breast.	Enteric—ileocæcal.	Deep and ant. rectus sheath sutures.
16	R. W.	M.	8 months.	8 hours.	Left loin.	Breast.	Ileocæcal.	Deep and ant. rectus sheath sutures.
17	M.R.F.	F.	2 years.	2 days.	Left loin.	Nothing abnormal.	Ileocæcal.	3 layers.
18	A.W.P.	M.	5 months.	14 days or 30 hours.	Left loin.	Breast, some bread.	Ileocolic—ileocæcal.	Deep sutures.
19	R. S.	M.	6 months.	25 hours.	Umbilical region.	Not stated.	Ileocolic—ileocæcal.	Ant. sheath and deep sutures.
20	L.C.W.	M.	9 months.	1 week.	Left loin.	Breast till eight months, then little bread and butter.	Ileocæcal.	Deep.

CASES, 20. Males, 12; Females, 8.

Ileocæcal	10 or 50 per cent.
Enteric-ileocæcal	4 or 20 " "
Ileocolic-ileocæcal	5 or 25 " "
Colic	1 or 5 " "
	20 or 100 per cent.

Duration of Operation.	Reduction.	Result.	Remarks.	Year.	Ultimate History.
Under 25 minutes.	Easy.	C.	Child apparently moribund before first operation.	1898, May.	January, 1904. Scar sound. Has attacks of vomiting, cause not to be made out. Died of acute strangulation by a band, June, 1904.
10 minutes.	Final part of ileo-cæcal difficult.	C.	Reduction by inflation had failed. Small enteric tumor remained after main reduction.	1899, May.	Well at end of six months. January, 1904, not traced.
7 minutes.	Difficult at cæcum.	D.	Wound found burst open on fourth day. Resutured.	1899, Jan.	Post-mortem. Cæcum still infiltrated with blood. Died on sixth day.
10 minutes.	Impossible	D.	Reduced to hepatic flexure, when outer coat was found to have sloughed in a linear manner for the extent of three-quarters of circumference of gut. Excision. Artificial anus. Food taken well. Bowels acted.	1899, April.	Died on tenth day. Post-mortem. Thrombosis of cerebral veins. No peritonitis.
10 minutes.	Easy.	C.	Pulse 160 on admission, abdominal facies, Tumor palpable only under anæsthetic.	1901, July.	Well in October, 1903.
10 minutes.	Difficulty at cæcum.	C.	Inflated three times, but recurred. Enteric tumor measured two and a half inches. Appendix normal in color, though cæcum was black.	1901, July.	Not traced.
13 minutes.	Difficult near cæcum.	C.	Appendix quite normal in color. Inflation had failed.	1901, Nov.	Well in October, 1903.
13 minutes.	Difficult.	C.	Tumor only felt under anæsthetic. Appendix normal in color, though cæcum was black.	1901, Dec.	Quite well. Scar sound, February, 1904.
Not stated.	Easy.	C.	Tumor could be felt in rectum.	1901, April.	January, 1904. Quite well. Scar sound.
9 minutes.	Difficult at cæcum.	C.	Appendix only slightly congested.	1902, Nov.	January, 1904. Quite well. Scar sound.
27 minutes.	Very difficult indeed.	D.	Appendix normal at base, but sloughing at apex, excised. Four inches of ileum through valve. Last two inches of ileum had a thick patch of infiltration on wall opposite mesentery, suggestive of a tumor; incision showed only blood in tissues.	1903, April.	Child died of marasmus. Post-mortem. Cæcum and several inches of ileum color black and almost gangrenous. Death on sixth day.
20 minutes.	Ileocolic difficult.	C.	Ileum through valve for space of three inches.	1903, May.	January, 1904. Quite well. Scar sound.
Not stated.	Easy.	C.	Dimple in the transverse colon at starting-point of tumor.	1903, Aug.	January, 1904. Quite well. Scar sound.
Not stated.	Easy.	C.	Wound found burst open, resutured. Six to eight inches of small gut through the valve, last two inches deeply congested.	1903, Sept.	Well some months after operation, 1904.
Not stated.	Easy.	C.	Small enteric separated by a distinct interval from the valve.	1903, May.	Well some months after operation, 1904.
Not stated.	Difficult at cæcum.	C.	Cæcum dimpled; apparently this was the starting-point.	1903, Nov.	January, 1904. Quite well. Scar sound.
Not stated.	Difficult.	C.	Large dimple on cæcum that would not be everted. Appendix normal in color.	1903, Feb.	Not traced.
20 minutes.	Extremely difficult.	C.		1904, Feb.	Cæcum burst open in attempt to reduce ileocolic portion. Inner middle layers extruded and reduced like a paraphimosis. Cæcum sutured.
15 minutes.	Easy.	C.	Appendix normal in color.	1904, March.	
20 minutes.	Impossible	D.	Gut ruptured just below splenic flexure. Not gangrenous, but extremely friable. Resection. Artificial anus.	1904, April.	Death in a few hours.

Died, 4. Mortality, 20 per cent.; or, excluding two cases of resection, 11.11 per cent.
Under one year of age: Mortality, 18.75 per cent.; or, excluding the case of resection, 13.33 per cent.

"The administration of opium is absolutely essential in these cases; there are substantial reasons for believing that under the influence of opium, administered early, an invagination may undergo cure by spontaneous reduction. Perceiving, as is probable, that no marked improvement follows, the next measure is in an attempt to reduce the invagination by means of enemata or insufflation. These modes of treatment have met with very encouraging success, and are worthy of a patient trial. Should these measures fail, there are substantial reasons for recommending an immediate laparotomy, especially in the young."

In twenty years, then, cœliotomy has risen from a last resource to a primary measure.

INTERSTITIAL HERNIA.[1]

BY CHARLES GREENE CUMSTON, M.D.,

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INTERSTITIAL hernia was described, probably for the first time, by Bartholini in 1661, although, from his writings, it is evident that his account is more or less ambiguous, and it was not until 1797 that the famous surgeon Jean Petit gave a more positive description of the affection. In the first quarter of the last century several varieties of interstitial hernia were described by Boyer, Hesselback, Astley Cooper, and Goyrand, while more recently Krönlein and Küster have occupied themselves with the question. The term of hernia interparietalis is due to Malgaigne, but he only goes so far as to say that the hernia is placed between the layers of the abdominal parietes. Finally, these herniæ were divided into three classes, as follows:

(1) Properitoneal inguinal hernia, situated between the parietal peritoneum and the fascia of the transversalis;

(2) Interstitial inguinal hernia, seated in the layers of the abdominal wall;

(3) Superficial inguinal hernia, found between the superficial fascia and the external oblique muscle.

The second type here mentioned can be divided into four subvarieties, according to the four possible locations of the hernia to which special names have been given by Göbell. He, however, does not believe this nomenclature advisable because of the confusion it might create.

There is no doubt whatsoever in my mind that the so-called hernia interparietalis is a true hernia, because it is possessed of a hernial sac formed by the peritoneum, a ring, and a contents. The ring is composed of Poupart's ligament below,

[1] Read by title at the meeting of the American Association of Obstetricians and Gynæcologists, St. Louis, September 13–16, 1904.

above by the free border of the internal oblique and transversalis, and inwardly by the rectus. In my own case the borders of the ring were smooth and tendinous in structure and was positively recognized as the internal inguinal ring. The sac simply contained a loop of small intestine, but in other cases reported the contents were composed of small intestine, the colon, omentum, cæcum, while in others the testicle, covered only by its tunica albuginea, was found deep down in the opening. The testicle has also been found free from the sac in a case recorded by Schindler and Steudner in which a gangrenous cæcum formed the contents of the hernia.

As will be seen by the report of our case, we do not think we are in error in considering it to be an inguinal hernia. Inguino-interstitial hernia was first definitely described by Berger, and, since this type remains within the limits of the external inguinal ring, it was suggested to call it hernia intrainguinalis. It is evident from the literature of the subject that interstitial hernia, that is to say, located between the external oblique and fascia transversalis, has given rise to considerable discussion, perhaps in reality more than the subject deserves. In his statistics, Macready shows that only 0.93 per cent. of all hernias are of the interstitial variety, while Berger, out of 7151 cases of hernia, only found five of the interstitial variety, making only 0.07 per cent. It should, however, be remarked that interstitial hernia is of the greatest interest to the surgeon on account of its serious nature. Macready collected 169 cases of interparietal inguinal hernia and Göbell, 115. The latter collection deserves, perhaps, more notice, for it includes reducible as well as strangulated hernia, whereas Macready has only considered the reducible form.

The term of interstitial hernia has been employed in various senses, but many surgeons consider that only that form of hernia which lies between the external and internal oblique should be classified under this head, believing that other varieties are simply subdivisions of this group. We believe that Göbell is in the right when he considers that all herniæ lying between some layer of the abdominal wall are of the interstitial

variety. Generally speaking, in a large majority of cases the diagnosis of interstitial hernia is attended with extreme difficulty, and, as far as the differential diagnosis is concerned, only fibroma need be thought of, because these growths are occasionally observed in this region, making their exit from the aponeurosis of the external oblique muscle. It is evident that the diagnosis of a hernia is made, but further than this it is difficult to decide the exact type with which one is dealing. The difficulty seems to lie in deciding whether one has to do with an inguinal or with a femoral hernia, and when the patient is a woman the diagnosis becomes still more faltering, because the frequency of the femoral variety in the female sex is well known. In our case the general appearance of the hernia, especially the large size of the external ring, rather led us to believe that the case was one of inguinal than femoral hernia. The presence of a typical inguinal hernia on one side and another hernia upon the other side is of importance because a relatively large number of cases have been recorded where the inguinal variety was present on one side and a femoral hernia on the other; and Berger found out of 10,000 operations for rupture that an inguinal upon one side and a femoral upon the other was present in 111 males and seventy females. Interparietal hernia is evidently more frequently met with in the male, and of the 115 cases collected by Göbell, only four were women; and it is well known that hernia in general is four times as frequent in the male as in the female.

Out of eleven cases of interstitial hernia collected up to the year 1900, not one was observed in the female; and I believe that Auvray, as far as I can learn, was the first to record a case of interstitial inguinal hernia in the female, and this he did in 1900; another case of the irreducible type in a young woman, operated upon by Helferich, was reported the next year by Müller. Fredet also reported a case in 1901. This year two more instances have been related by Brunco in his thesis, "Zwei Fälle linksseitiger interstitieller Hernie beim Weib," operated on by Glaser.

Since a large number of the interparietal type, and all the

cases of the interstitial variety recorded up to this year (1904), have been associated with displacement or some anomaly of the testicle, these conditions were naturally looked upon as the cause of the particular form of rupture. Cryptorchidism was more particularly dealt with. Göbell has calculated that, of all the cases of interparietal hernia that he has been able to collect, 59.1 per cent. were cryptorchids, and that in his eleven cases of interstitial hernia all presented this anomaly. Retentions of the testis, whose relation with an abnormally narrow external inguinal ring will be considered later, can only be considered as an etiological factor of interparietal hernia in very rare instances, because only 10 per cent. of males afflicted with this condition presented this type of hernia; but Göbell, who makes this statement, refers, however, to certain congenital conditions as the origin of this form of rupture. He considers that all of his eleven cases of interparietal hernia, occurring between the external and internal oblique, were congenital. In one case recorded by Brunco, the patient stated that the hernia had been present exactly three years, but one should recall to mind that oftentimes an inguinal hernia may exist for many years in the female, and yet the patient's attention not be drawn to it; and then, again, one should recollect, as Lockwood has pointed out, that in exceptional cases a loop of mesentery may be inserted so high up and it may be so short that a complete extrusion of the gut through the rings would be practically an impossibility, in which case we are dealing with a so-called incomplete hernia. An internal inguinal ring with a very high situation has been recorded by Bramann in a case of an inguinal hernia lying between the external and internal oblique muscles, in a four-year-old boy. Close to the border of the ring the testicle was found. In another case recorded by Schmidt and Butz the internal ring was five centimetres higher up than normal, and quite on a level with the anterior superior iliac spine. In Kleeberg's case the internal ring was not distant more than five centimetres from the external. Schmidt attributes this anomaly to a defective situation in the insertion of the ligament of the kidney. Bramann takes it for granted that there is a displacement of the

normally grown structures, especially in those instances where the lower border of the processus vaginalis only reaches as far as the aponeurosis of the external oblique muscle, and Berger has also mentioned abnormal conditions of the inguinal ring in females. From the resulting occlusion of the internal inguinal ring, it would appear that the narrowing of the external inguinal ring, which is so often observed, is the result of the changed condition of the internal. In the case which we report, the external inguinal ring was very large, perhaps I might say abnormally so; while, on the other hand, in a typical case of interstitial hernia recorded by Butz, the external ring was so small that the operator could not find it. Bull and Coley, in their article on Hernia in Dennis's " System of Surgery," state that in the female there may be a hydrocele of the canal of Nuck preventing the hernia from enlarging in the usual direction. This may be quite possible; but, so far as I am aware, no such case has been reported, unless the writers making this statement have had such instances under their observation, but of which they make no mention.

In the male, the narrowing of the external inguinal ring has been considered an obstacle for the complete descent of the testicle, and as a cause for the spreading out of the interparietal processus vaginalis behind the internal ring. In contrast to this, the herniæ, which interest us more especially, have presented, in cases where the rupture was reducible, an abnormally large external ring. Be that as it may, these conditions, especially in the female, are still most indefinite, and it would be well in the future if more detail were given in reference to them. The stretching and thinning of the aponeurosis of the external oblique, as observed in one of Brunco's cases, should not be in any way connected with the above-mentioned congenital defects, and, as he points out, was simply secondarily dependent upon the pressure of the hernia.

Göbell goes into every imaginable supposition in order to explain the formation of interparietal hernia, but these we will omit from discussion and will consider the process as it occurs in females. As obstacles to the centrifugal mobility of the

hernial sac may be mentioned, firstly, the extreme obliquity of the inguinal canal or considerable loose tissue of the interstitial parts, thus predisposing the entrance of the hernial sac; secondly, a narrow external inguinal ring. The space between the aponeurosis of the external oblique and internal oblique forms a point of lesser resistance and would naturally be most favorable for the development of a hernia. It is almost surprising that not infrequently a hernia will push itself between the firm sheaths of the transversalis muscle and the fascia transversalis, and, in order to accomplish this, a rather powerful centripetal force must come into play.

Eppinger, who divides the inguinal canal into three portions, explains the frequency of inguinoproperitoneal hernia from the fact that there exist two especially weak spots in the last division of the canal, between the peritoneum and the fascia transversalis, thus favoring the development of a hernia between them.

Symptomatically, interstitial hernia forms an abdominal swelling when it makes its exit through the abdominal ring, or when the interparietal sac is greatly developed and contains a good sized contents. But it should be recalled to mind that there are instances of interstitial hernia where no tumefaction is present, as an example of which we may cite the inguinoproperitoneal variety.

Statistics show that interperitoneal inguinal hernia occurs about twice as often on the right as on the left; and among the eleven cases observed by Göbell of inguinal hernias seated between the external and internal oblique muscles, only three were found on the left side. This authority believes that for this reason one is dealing, at least in the case of males, with a congenital hernia, for the reason that this process is more frequent on the right than on the left side, because the right testicle descends at a later period, and for this reason the right processus vaginalis remains patent longer than on the left.

Relative to the age at which interperitoneal hernias have been observed, it may be said that in the male, at least, the subjects have varied in age from twenty to forty years,—in other

words, during the time when, from work, intra-abdominal pressure is apt to be the greatest. One case in a boy four years of age has been recorded. On the other hand, in females with interstitial hernia, the patients have, in most cases, been over fifty, although there is no hard and fast rule, for many cases have been recorded in younger females and even in little girls, as in our case; and it is my impression that Mr. Bland-Sutton has recorded a case in a female infant four months old, although I am unable at the present time to find a reference to it.

The sac of an interstitial hernia may be single or bilocular; in the latter instance there will be a hernial sac in the inguinal canal, and another in the interstitial tissue of the abdominal wall.

The prognosis of interstitial herniæ which have not been operated upon is decidedly more unfavorable than that of inguinal hernia in general, because in the former their anatomical make-up renders them far more liable to strangulation, and 50 per cent. of Göbell's cases were examples of incarcerated hernia. From these facts, therefore, it is evident that the only proper therapeutic measure is a radical operation, and the longer such hernias are allowed to go on without operation, especially if they are wearing a truss, the more unfavorable will become the operative prognosis.

No absolute rule can be laid down as to the technique to be employed, because the anatomical conditions will vary somewhat from one case to another, and it is evident that the operation will usually be to some extent a complicated one. A very complicated method for the radical cure of interstitial hernia has been suggested by Berger, who alternately sutures the muscles and layers of fascia over one another, the sheath of the rectus being drawn over in order to add strength. After a vertical separation of the anterior abdominal wall, the structures are brought over below and outward, and this muscular transplantation is completed by several layers of buried sutures. Delorme and Championnière have each described their personal methods, which space will forbid us from considering, and we will now briefly give the history of our case.

The patient, a well-developed girl nine years of age, was referred to us in August, 1904, by Dr. Robert D. Scales, of Dorchester, for a right-sided inguinal hernia. The patient had been passing her vacation in the country, when suddenly, one afternoon, she was taken with severe intra-abdominal pain, which was diagnosed at the time by a local physician as being due to appendicitis. The child was put to bed, the pain gradually subsided during the night, and the next day she was well again. From the subsequent findings at the operation, it was evident that she had suffered from a partial strangulation, but from the recumbent posture the gut had probably slipped back into the abdominal cavity, and no further disturbance arose.

Examination showed a normally developed, well-nourished girl, with excellent muscular development. Lungs and heart normal; abdominal viscera normal. In the right inguinal region, a tumefaction, the size of a small hen's egg, was to be seen extending downward towards the labium majorum, more or less pear-shaped. With the patient standing up, a distinct impulse could be felt on coughing, and when the child was placed in a decubitus the swelling could be readily reduced. After reduction, the tip of the index-finger could be easily inserted through the external inguinal ring up the canal. Upon requesting the patient to stand up, another tumefaction was observed to occur somewhat above the inguinal hernia, and appeared to occupy the abdominal parietes. Impulse could be detected in this tumor when the patient coughed, and it also disappeared when she assumed a recumbent position.

This second tumefaction appeared at about the middle of Poupart's ligament, and when slight pressure was used it was made to disappear within the abdomen, accompanied by a slight gurgling. On deep pressure one was able to discover a rather oval gap at the site of the swelling, which easily admitted two fingers; and by exploration it was discovered that above and externally it appeared to be surrounded by rather tough bands of what appeared to be adhesions, while below the pubic bone formed its lower boundary. The pelvic vessels were felt directly below the lateral angle of this gap. Extending from the tuberosity of the pubis, a second gap, with sharply defined borders and triangular in shape, could be detected and easily admitted one finger.

The tumefaction above that of the inguinal hernial swelling

could only be produced when the patient stood up and coughed, so that a considerable amount of intra-abdominal pressure was brought to bear. When this was done the protrusion appeared at first to be directed towards the median line; but if the intra-abdominal pressure was still continued, it deviated laterally. It could only be replaced when the patient was in a recumbent position, and this was accompanied by the characteristic gurgle, proving that the contents was composed of intestine.

An incision carried downward towards the external inguinal ring about eight centimetres long was made, and, after the skin and superficial fascia were separated, the aponeurosis of the external oblique became visible and contained several longitudinal sulci parallel with Poupart's ligament. The external inguinal ring was not very distinctly defined. After slitting up the aponeurosis of the external oblique, the hernial sac immediately bulged out and, so to speak, unfolded itself from under the aponeurosis, and was found to extend above the internal oblique and downward underneath the aponeurosis. The sac was adherent to the superficial fascia at the level of the internal ring, and after freeing it from the internal oblique the transversalis appeared to have no adhesion with it. A lipoma was found connected with the hernial sac and was adherent to the fascia and symphysis pubis. This was separated, and a fairly well developed round ligament was discovered attached to it. The sac was then with some difficulty dissected away from all the surrounding parts, and when this had been accomplished it was found that it extended through the transversalis, forming an opening large enough to admit two fingers. Within the hernial sac three small lipomata were found, while the contents consisted of a loop of small intestine.

It was evident that the internal inguinal ring lay to the side in an abnormal position, and when the sac had been completely isolated and spread out, it was closed with catgut sutures and excised. The stump was allowed to drop back into the abdomen, and the transversalis was sutured to the border of the aponeurosis of the external oblique down to the sheath of the rectus, while the internal oblique was sutured to the upper border of the aponeurosis of the external oblique, and the lower border was brought over upward upon the aponeurosis, so that there were four rows of buried sutures overlying the hernial opening.

The after events were simple, and the patient was discharged well at the end of three weeks.

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THE RELATION OF MECHANICAL DISTENTION TO THE ETIOLOGY OF APPENDICITIS.[1]

BY C. VAN ZWALENBURG, M.D.,

OF RIVERSIDE, CALIFORNIA.

IN a study of appendicitis, four conditions point the way to its etiology. 1. The constriction; 2. The concretion; 3. The pathogenic germs, always present; and 4. The distention, observed in early operations.

These have all been repeatedly commented upon in searching for the cause. One other necessary condition is the hydrostatic pressure in the distended appendix. Pressure upon the blood-vessels in the interior of the appendix lowers the resistance and the germs do their work. If continued, it obliterates blood-vessels and produces necrosis and gangrene. Many attempts have been made to explain the vascular changes by trauma or pressure from concretions, foreign bodies, or kinking or torsion; but the fact that the fluid can produce pressure upon blood-vessels as well as solid bodies has been overlooked. What will furnish a more simply or satisfactory explanation than this fluid distention?

The appendix is essentially composed of a hard, resisting, muscular wall enclosing a mucosa and submucosa and covered with peritoneum. The blood-vessels branching in the meso-appendix pierce the wall in many places and, *ramifying the submucosa*, supply the mucosa. The latter is rich in lymphoid tissue. The lumen contains mucus, fæcal matter, remains of food, and a rich supply of bacteria.

Given a constriction in any part of the lumen of the appendix with a concretion behind it (passing the mode of their formation for the present), let us briefly trace the process of

[1] Read at the meeting of the Foothill Medical Circle of Southern California, November 16, 1904, at Redlands, California.

distention and inflammation. In any one of a number of ways the concretion closes the opening in the constriction. Secretion from its numerous glands may furnish the first fluid in this closed cavity, or there may be a considerable quantity of fluid already present at the moment of closure; it may be sufficient to produce decided pressure immediately.

There are now three different fluids involved in this process, all subject to different pressures and separated by only the filmiest membranes.

1. The afferent vessels (the arteries) carrying fluid into the appendix at a pressure of, say, 125 millimetres mercury;

2. The efferent vessels (the veins and lymphatics) carrying fluid out of the appendix at from nothing to ten millimetres;

3. The fluid in the occluded cavity subjected to a pressure of, say, twenty-five millimetres, may be anywhere from ten to 100.

Hydraulics and dialysis tell us what follows in the struggle for hydraulic equilibrium. The efferent vessels which are within the resisting wall of the appendix will be more or less occluded by the greater pressure in the cavity. The capillaries responding to the obstruction beyond dilate and allow serum to escape; lymphatic drainage is blocked, effusion results. Every atom of fluid which remains within the wall of the cavity adds its pressure to that already present and causes greater obstruction to the efferent current. The arteries keep on pumping in the fluid at 125 millimetres; effusion continues, and the pressure in the cavity rises and continues to rise until it equals that in the arteries, and these pressures are balanced at 125 millimetres, or whatever the arterial tension may be.

Now, if this occurred in perfectly sterile surroundings, this balance might be maintained for some time without material harm; enough fluid would filter through to maintain life in the cell. But our cavity is far from sterile; that innumerable numbers and varieties of germs make this their home has been repeatedly demonstrated. With the circulation impeded, the tissue cells, deprived of their supply of food and oxygen, offer

little resistance to the attack of germs. The leucocytes are prevented from reaching the point of assault; the mouth of every follicle and gland and lymphatic is opened wider with every increase of pressure—doubtless microscopic trauma occurs. What more perfect conditions for "infection" can be conceived?

With the increase of pressure and the infection infiltration, complete strangulation, necrosis, and gangrene follow. Our cavity is now a real abscess cavity, subject to the same laws of hydraulics, circulatory interference from hydrostatic pressure, infection infiltration, necrosis, and advance in the direction of least resistance.

The comparison and detailed study of these processes in an abscess and in the appendix open an attractive field, but I cannot take time for that now.

Assuming that the obstruction does not give way, necrosis appears; first in the most vulnerable portions; thin places in the wall; parts having the poorest circulation or those affected by the most virulent infection. These break down and we have a perforation. Or if the pressure and infection are about equal in all parts of the wall, or of sufficient intensity or character, gangrene of the entire enclosed cavity will result.

Time and again such appendices have been removed within twenty-four to forty-eight hours of the onset of the first symptoms; often they are so distended that the surgeon fears they will rupture during removal; often one or more black necrotic spots are in evidence, to which protective omentum has already become adherent; or the entire appendix or that portion distal to the obstruction has been found gangrenous, but still intact. This is the ideal appendix we all strive for by early operations, and fortunate is the patient who parts with it at this stage.

In my own experience, this condition of distention obtained in every case in which the time and character of the case made it possible. Surgeons generally tell of such experiences, and many promptly add, "I can see how your explanation will account for this class of cases." If for these, then why not for

those in which perforation has already taken place. To be sure, the fluid has been disseminated or is confined in a local abscess, and the walls of the appendix are collapsed; possibly the entire appendix is wellnigh lost in the mass of necrotic tissue present. Still, the case found distended at thirty-six hours after onset would have been in this same collapsed condition if left until the third or fifth or eighth day.

I must put the same argument for those other cases in which the direction of least resistance drives the concretion out into the colon. Here even the concretion is lost, and the only evidence of the condition which prevailed a few hours or minutes before is the distensible cavity with inflammation *beyond the point of constriction.*

Nevertheless, is not the analogy complete? If the constriction will in time dilate sufficiently to allow the concretion to pass under the increasing pressure, that will be the direction of least resistance. The contents will be discharged into the cæcum and the injury done to the appendix will be repaired as best it can. If the infection has only begun or is of a mild character, repair will be easy, and the continuing appendicitis will be of the so-called catarrhal type. It may be so mild as to escape observation entirely, the patient never knowing that anything unusual occurred within his abdomen. If the concretion is not passed into the colon until the distention reaches a high point or until it has been a practical strangulation for some time, or if the character of the infection is very virulent, serious changes may have taken place, necrosis, even gangrene, may continue, or the infection may continue to advance through the wall of the appendix without necrosis and produce peritonitis, or it may follow any of the devious courses so inimical to appendicitis.

So far I have considered only those typical cases which contain a great amount of constriction, together with an actual concretion. Neither of these is, however, essential to the production of appendicitis nor to this explanation of its etiology. Strictly speaking, this distention is really a step in the early pathology of the disease, but, as it is the cause of the acute attack, it is indeed the cause of the illness which we call appendi-

citis. A number of conditions will vary the course and the final result of this obstructive process. The constriction may occur at any point in the course of the lumen from the colonic junction to within one-half inch of the distal tip. Likewise, it varies in size from the slightest narrowing to the tightest constriction. It may be only an unusually small "valve of Gerlach," or it may be a cicatrix encircling the lumen and closing it to a pin-point opening. It may be only a "kinking" of the appendix.

The obstruction need not always be a concretion. A fæcal mass of varying size and consistency may obstruct for a sufficient length of time to produce tension, vascular changes, and infection. Under these circumstances, the infection will probably be less severe. In fact, a concretion is simply the insoluble inorganic residue of fæcal masses growing by accretion, the organic matter disappearing by digestion, bacterial action, and solution. If the constriction is very tight, possibly a plug of mucus might furnish the obstruction for a slight distention, and a mild infection, the resulting congestion of the wall completing the closure.

The determination of the degree of tension necessary to produce infection opens up an interesting field for study and experimentation. The actual manner in which closure of the trap occurs must of necessity be partly left to conjecture. The most reasonable explanation is that it depends upon accidental circumstances. I have demonstrated on an appendix which contained a concretion how easy it is to force fluid into the appendix which, by its recoil, forces the concretion into the constriction, and closes the cavity by a perfect ball-valve. It seems reasonable, from the suddenness and severity of many attacks, that that does actually happen in many cases.

Anything increasing tension in the colon thus becomes responsible for the actual onset. Diarrhœa, constipation, fermentation, flatulence, trauma, athletic strain, all these have been charged with being the cause of appendicitis; and I can see how by increasing intracolonic pressure they may be the last straw which springs the trap. Often, however, I believe the

closure is purely accidental. It will come on during sleep; the position of the patient may favor it. The constriction and concretion may be ready for the final tragedy for months or years, and only await the accidental closure to bring on an attack. In fact, they are often found post-mortem after death from other causes.

It should be remembered that the concretion forms in the very mouth of the constriction, being moulded to a perfect fit by the frequent attempts of the appendix to empty itself. Still, it may for a long time remain a poor fit, and the moment pressure increases the valve leaks, the concretion falls back into its bed, and the attack is postponed. The same is true of fæcal masses.

No doubt one cause of closure is the attempt of the appendix to empty itself by the contraction of its muscular fibres, the presence of which is no longer a matter of doubt. Once closed, the appendix continues these attempts to empty itself, producing appendicular colic. This is to my mind the most reasonable explanation of the first colicky pain which is the most characteristic symptom of the onset of the disease. This " spasm," originating in the appendix, spreads to the adjoining colon and ileum, and is in some cases responsible for diarrhœa during the first few minutes or hours of the attack.

Rubin, in the *Journal of the American Medical Association*, Vol. xliii, No. 18, demonstrates how flatulence favors the entrance of colonic contents into the appendix. In so far as it does so, it favors the production of a plug as well as a closure of the constriction, and in that way may be a factor. After the trap is closed, the formation of gas from fermentation of the enclosed contents sometimes adds rapidly to the existing pressure.

R. Abbe [1] has beautifully demonstrated the formation of strictures from the ulceration following an attack of appendicitis, several often occurring in the same appendix. That all narrowing of the appendicular lumen is thus produced does not however follow. Many of the irregularities of the appendix

are congenital. The club-shaped, long, narrow, or short thick appendix, the kinks, the short mesentery, and numerous other constricting conditions are simply accidental and congenital, the simple result of the degeneration of a rudimentary organ. Hence, a person is destined to have appendicitis some time during his life or not, according to whether he is born with a respectable appendix or not. And the pronounced attack is most likely to occur during the period of full development of these irregularities, not far from the period of adolescence.

These irregularities are often hereditary, like all other minute anatomical peculiarities, and that explains the hereditary features of the disease. I have seen it occur in two brothers and one sister within two years. The first attacks are usually mild, and doubtless occur during childhood, and are constantly overlooked both at that time and later in the history. What boy of ten to fourteen would think of remembering such little "belly-aches"?

The natural irregularity of the lumen retards the passage of a fæcal plug sufficient to allow a moderate distention to take place. It takes but little pressure to retard the venous and lymphatic current, lower the resistance to germs, to open the follicles and crypts of the appendix, perhaps produce minute traumatisms, and inaugurate a mild infection before the lumen again becomes patulous. This infection by infiltration, ulceration, and cicatrization tightens the stricture, and often produces others. How often do clinical histories report several such mild attacks months and years preceding the stormy one which ends in complete occlusion and resulting perforation.

Occasionally a distended appendix is found which presents no gross evidence of active inflammation, or, if it does, it is very mild. This occurs as a result of an attack of appendicitis which has run its course. In the light of these studies, I would explain these by saying they are a result of the process of resolution, the infection being mastered by the tissues, and the lumen occluded by adhesive and cicatrical processes; a cavity is left which becomes or remains distended by the hydraulic

processes I have described, but as it contains no germs it produces no infection.

Sometimes a small cavity becomes permanently occluded; the few germs which it contains produce a mild infection and slight symptoms of appendicitis, but it is so mild that the germs are killed and the infection overcome without a perforation. The distention thus remaining may then continue indefinitely.

That this is indeed the explanation of the nature of appendicitis is emphasized by the following facts:

It is not sufficient to say appendicitis is due to germs which happen to lodge in the appendix as we can of most infectious and contagious diseases. No idiopathic germ can be charged with being the etiologic factor. We find no germs there which could be said to be introduced into the body for this special occasion. The germs involved in the process are normally present in the appendix in health.

The suddenness of the onset in many cases can hardly be explained except on the ground of a sudden mechanical change having taken place. The sudden cessation of spontaneous pain likewise indicates the giving away of a mechanical something which to the patient himself suggests the removal of some kind of an obstruction in the abdomen.

The inflammation, until it spreads along the peritoneum, is confined to that portion of the appendix beyond the particular constriction which causes the trouble. How often we find only the distal inch involved, and the balance of the organ proximal to the constriction as healthful as ever. Again, the inflammation is evenly distributed over that entire portion so involved, and that very early in the case, before it could have time to spread by continuity.

The frequency of necrosis and gangrene indicates mechanical obstruction. Simple infection does not do this except in abscess formation. The only abscess early in appendicitis is such as I have described occupying the lumen itself.

Then, why is the necrosis or gangrene confined to the portion beyond the stricture, unless that stricture is to blame for it? If the necrosis is due to infiltration pressure following simple

infection, why should it be content with a simple perforation? Why does it not spread to the balance of the appendix and the colon, the omentum or mesentery? Often we find a small, simple abscess just outside of the perforation with an infection so mild that it is arrested right there. Would such mild infection produce necrosis from pressure infiltration? Why, then, do not we have necrosis of other portions of the alimentary canal?

Almost invariably the stricture or kink will be found prominent in proportion to the severity of the attack. In mild cases comparatively little stricture will be found.

To practically test the effect of tension upon this problem, I made a series of experiments on dogs. The appendix was ligated subperitoneally at its juncture with the colon. I am told that, strictly speaking, the dog has no appendix, that it is merely an elongated colon, but in shape, position, and general anatomical characteristics it resembles the human appendix so closely that for practical purposes it is an appendix.

An aspirating needle was passed through the wall of the colon into the lumen of the appendix, and through this the appendix was distended with tap water at any pressure desired, a manometer being used for that purpose. Cultures of Staphylococcus albus and colon bacillus were introduced into the appendix in a few cases.

The experiments were detailed in the *Journal of the American Medical Association* for March 26, 1904, so I shall not repeat them here, but merely give the summary of results. There was no difficulty in producing the picture of appendicitis, but we found that the one essential condition for its production was that the organ be distended. In all cases in which this condition was complied with the results were strikingly typical of human appendicitis. The tension was varied from seventy-five to 150 millimetres mercury, and continued for two hours or more, and in all these cases a typical appendicitis followed in twenty-four or forty-eight hours.

The other experiments of ligature simply, or of injection of cultures without a simple ligature, or with it, all failed to

produce any effect upon the gross appearance of the appendix in twenty-four or forty-eight hours.

I find in the literature reports of a number of attempts to produce appendicitis in animals experimentally. The more important ones were those of Roger and Josne,[2] Cappelon,[3] Beausenat,[4] Nicholayson,[5] Lipavski,[6] Roux,[7] Adrian,[8] Mühsam,[9] and Baudler.[10] Usually the attempt was made to produce infection by some irritation or traumatism of the interior of the appendix. Several workers have injected cultures of various germs into the appendix. General infection through the blood was tried. After injecting virulent cultures of bacteria into the appendix and adding considerable traumatism, a limited infiltration is reported, but nowhere do I find a report of that general inflammation of all the coats of the appendix which gives us the picture which we call appendicitis.

In order to produce any results, the circulation must be retarded by distention and consequent pressure, and when this is done the germs normally present in the appendix promptly produce infection.

The practical bearing of this view of appendicitis upon the diagnosis and treatment is very evident. Some of its most valuable hints come from a careful study of the history of pain and tenderness during the first hours of the attack.

If the distention comes from a sudden increase of intracolonic pressure produced by athletic exertion, or accident, or gastro-intestinal disturbance (forcing fluid into the appendix, which, by its recoil, forces the concretion into the constriction, closing the ball-valve), the onset will be characterized by severe pain coming on suddenly. If the occluding mass is small or pliable and is forced out through the constriction by the increasing distention, there will be a sudden cessation of acute pain. If the occlusion is permanent (that is, if the plug is too large to pass, too hard to be compressed, and fits too accurately to allow of a leak), distention will increase until the circulation is arrested, and necrosis or gangrene will follow. After a time the nerve endings involved in that process will fail to report pain and the patient feels relieved, but we know it is only the lull

before the storm, which breaks out with redoubled fury when the gangrenous tissues give way and allow the pent-up flames of infection to burst out upon the peritoneum.

I believe that in many cases we can diagnose these different conditions accurately by carefully studying the history. If I get a clear history of acute, colicky pain continuing less than an hour, or even two hours, with a fairly sudden cessation, I feel confident that the obstruction has given way, and that only a so-called catarrhal appendicitis is to be expected. There will still be pain upon moving about or from rolling of intestines, and there will be tenderness upon pressure, but no more acute, spontaneous pain. This means inflammation in the appendix, but relief of the distention and strangulation.

Again, when the pain has been severe for several hours, there has been frequent vomiting and perhaps two or three attempts at stool; there can be no practical doubt that the distention will not be relieved through the anatomical exit into the colon, but by rupture of the appendix, following necrosis or gangrene.

If this acute pain gradually diminishes after six or twelve hours, it is quite certain that considerable gangrene is present, usually complete gangrene of the appendix beyond the constriction.

The sudden reappearance of severe pain twenty-four to twenty-eight hours after beginning of the attack means peritonitis following. There are, of course, cases on the border lines in which the actual condition cannot be known; but generally the distinction between the so-called catarrhal cases and perforative ones can be made out and the presence of absence of peritonitis can practically always be determined.

A patient of mine recently gave a typical history of recurrent attacks of mild appendicitis in one sentence. She said, "I would have severe pain for a short time, and then be 'so sore' for several days afterwards." This is the characteristic history. Severe pain while the distention and strangulation continue; relief from acute pain as the obstruction escapes, but continued

tenderness from the inflammation meanwhile established, by the germs driven into the exsanguinated tissues.

The treatment as suggested by this theory may, in the first stage, be likened to that of strangulated hernia. The pressure upon the blood-vessels is practically a strangulation. If the strangulation is not promptly relieved, necrosis or gangrene will follow. We say, "Don't allow the sun to set upon a strangulated hernia." We may say with equal propriety, "Don't allow the sun to set upon a strangulated appendix." Could we always know what strangulation was or was not relieved, the indication would always be clear. Unfortunately, we cannot *always* be certain. Still, study, from this stand-point of distention as a cause, throws a flood of light upon the subject, and failure to make this diagnosis should be rare. Unfortunately, again, patients so commonly fail to call the surgeon during this early period, when it is simply a question of strangulation. In a large proportion of cases it is the resulting infection which claims the attention of the surgeon,—so often already a peritonitis. If the pain has been slight and of short duration, and only slight tenderness remains, it is safe to say that the case needs no treatment from that attack. Of course, he will probably have further attacks, and need his appendix removed on that ground. The appendicular colic is evidence of a constriction. A plug of fæces or a fæcal concretion will reform and sooner or later produce another attack. But for the present he is safe with a simple catarrhal appendicitis.

The possibility of dislodging this plug either into or out of the appendix by some form of taxis or massage occurs to me, but I have had no opportunity of testing it. As a matter of fact, we are rarely called early enough to apply it (within three or four hours), and many anatomical difficulties present themselves.

Operation, if performed at all, must be done before perforation, or peritonitis, supervenes. The question of early operation should be settled early, within twelve hours if possible, almost certainly within thirty-six hours, and at least within forty-eight hours of the onset of symptoms. It is impossible to

make rules by hours or by the severity of the pain. Distention advances at such varying rates and the virulence of germs varies so greatly. The weight given to the evidence derived from a careful study of time and pain must depend upon the judgment and experience of the surgeon. It is comparative evidence and cannot be tested by a fixed measure. It should be only the most positive evidence that allows the case to go on with the assurance that only a mild attack without consequence is impending. When in doubt during these early hours, I advise operation every time. If the error is made of removing a catarrhal appendix early, no harm is done. It is even then a good riddance to the patient.

But appendicitis is treacherous, and more than time and pain must be considered. Sometimes the most serious cases have little or no pain during the first few hours. All the symptoms must be studied, of course, but always bearing in mind the probable stage of the strangulation. But, unfortunately again, we are so often called upon to consider this question of operation when we know the case is one of peritonitis rather than appendicitis only. It may be limited to a small portion of the peritoneum, may be a walled-off abscess, but, nevertheless, peritonitis. The removal of all the infected tissue is now out of the question, and to my mind Ochsner has conclusively proven that a much larger percentage of such cases get well if left alone than if meddled with by operation. A certain number will die with any kind of treatment, but my personal experience with both forms or procedure is overwhelmingly on Ochsner's side of this exceedingly serious controversy.

In the presence of acute peritonitis a focus of acute infection is certain to remain after operation, and the danger of its spreading is immensely increased by the intestinal paralysis, the interference with the normal secretions of the peritoneum, and the removal of the barriers already thrown up by nature's protective forces.

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TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY.

Stated Meeting, November 23, 1904.

The President, HOWARD LILIENTHAL, M.D., in the Chair.

MULTIPLE SPONTANEOUS FRACTURES.

DR. CHARLES L. GIBSON presented a woman, forty-nine years old, who gave a fairly well-defined specific history. Aside from this, her past history had apparently no bearing upon her present condition. Seven years ago, a spontaneous fracture of the right ulna had occurred. At the site of the fracture, a lump, presumably a gumma, had previously been observed. This fracture had never united, and the patient stated that no attempt had ever been made to induce it to unite. Two years ago a spontaneous fracture of the proximal phalanx of the right middle toe occurred. Seven months ago she fell out of bed and sustained a fracture and dislocation of the left shoulder. About three months ago she noticed a swelling over the right clavicle, and a spontaneous fracture subsequently occurred at the site of the tumor. All these fractures were perfectly painless, and a considerable amount of function of the affected parts was retained. Dr. Gibson thought there was little doubt that the underlying clause of these spontaneous fractures was syphilis. In most of the cases of the kind on record, the bones united. The patient had been put on specific treatment, but the speaker said he did not expect much benefit therefrom.

DR. ROYAL WHITMAN called attention to the fact that the fractured clavicle had apparently united. The fracture of the shoulder, he said, could hardly be called spontaneous, as it had been produced by a fall out of bed. It was rather interesting that the fractures, aside from the one involving the phalanx of

one toe, were confined to the upper extremities. He recalled a number of cases of spontaneous fractures in children whose bones were congenitally weak, in one instance as many as twenty or thirty fractures having occurred. The patient was a boy who could at one time hardly turn in bed without sustaining a fracture of some bone. He was kept in plaster-of-Paris for years, and finally recovered, although, as is the rule in these cases, a dwarf in stature.

OSTEOPLASTIC AMPUTATION OF THE LEG.

Dr. Howard Lilienthal presented a man, thirty-eight years old, who, when he first came under observation, had a sloughing gangrene of one big toe, with threatened gangrene of several of the adjoining toes, the cause evidently being an arteriosclerosis. The affected toe was amputated, but the disease progressed; and it finally became necessary to amputate the leg, which was done in April, 1904.

As the cause of the gangrene was arteriosclerosis, with presumable hardening of the bones, the speaker said he regarded a simple amputation, done as rapidly as possible, as most advisable; but he was finally persuaded by Dr. A. V. Moschcowitz, who had had considerable experience with certain osteoplastic amputations, to try the osteoplastic method. In a much more promising case than this, in which Dr. Lilienthal had tried that method a year before, the patient became somewhat septic, necessitating removal of the bone-section. Subsequently, the patient became insane, and was transferred to Bellevue Hospital. In spite of the unsatisfactory result in that case, and in spite of the fact that an osteoplastic operation was apparently contraindicated in the case just shown, the operation was undertaken with Dr. Moschcowitz's assistance, and, contrary to the speaker's expectations, the result was excellent. There was a slight infection following the operation, due to the fact that the wound had to be left open, and one or two small superficial necrotic pieces of the fibula came away, but the main section of bone remained in place. The cicatrix of the stump was in a location where, under ordinary conditions, it would be painful; but under the circumstances it was not painful at all, and the man was able to bear considerable weight on it without inconvenience. The bones were eburnated, and so brittle that fissure of the tibia occurred on fracturing of the osteoplastic

flap. Division with the Gigli saw was very difficult. The stump left, however, was infinitely better than could be obtained by any of the ordinary methods, even with a periosteal cuff. Dr. Lilienthal said he would certainly resort to the method again in similar cases, and in amputations of the femur also.

DR. WHITMAN said it was rather peculiar that only one leg was affected. The speaker said that this condition of arteriosclerosis was not uncommon in comparatively young people, and especially among the Jewish race. These patients complained of pain in the legs and calves, often more pronounced at night, and of "weak feet," and an examination usually showed that the toes were of a deep violet color. Both lower extremities were generally equally affected.

DR. LILIENTHAL, in reply to a question, said that the section of bone protecting the stump had been left attached by a periosteal hinge, so that it could be turned on itself. The fragment of bone should be handled as little as possible; otherwise, the periosteum was apt to become stripped off entirely.

Dr. Lilienthal said that while these cases of gangrene resulting from arteriosclerosis were rare, he had seen and operated on quite a number of them. As Dr. Whitman had said, they appeared to be more common among the Jewish race, and every year a certain number of them came under observation at Mount Sinai Hospital. The condition was usually bilateral, and in one case that had recently come under his observation, a young man of twenty-eight years, a Lisfranc amputation was necessary on one foot and a leg amputation on the other side. In the case under discussion, the patient complained somewhat of the opposite foot, but the condition had not progressed to the point of gangrene. As to the etiology of the condition, no positive statements could be made. The cases were variously described as Raynaud's disease, arteriosclerotic gangrene, and erythromelalgia. In its terminal stages, after the onset of the gangrene, it was a disease of the blood-vessels, usually of the arteries, sometimes of the veins also, and apparently depending on some nerve lesion. It usually occurred in early middle life, and was seldom seen in old people. In his experience, the oldest patient was fifty-six years. It was unusual to get a syphilitic history in these cases, and he did not think that syphilis was an important etiological factor in the disease.

A DEVICE FOR THE TREATMENT OF FRACTURE OF THE FEMUR IN CHILDREN.

DR. THEODORE DUNHAM presented this device.

DR. CHARLES N. DOWD referred to the difficulty of treating this form of fracture in children under one year of age. He referred to the device which the late Dr. Van Arsdale had suggested a number of years ago. This consisted of a triangular splint which was fixed between the flexed thigh and the body, to one side of which the thigh was bound. He had found difficulty in maintaining good apposition with this apparatus, and would certainly try Dr. Dunham's method if the opportunity presented. In older children he had found the suspension treatment very satisfactory.

DR. WHITMAN said that in his experience with fractures of the femur in young children in the out-door service, union of the bone was usually very slow. This was probably due to the fact that the ambulatory treatment of these cases by the ordinary methods was unsatisfactory and difficult to carry out, because, as a rule, fractures in children united very readily. Even the method described by Dr. Dunham might be difficult to apply in this class because of the soiling and displacement of the plaster dressings.

DR. DUNHAM, in closing, said it was a fact that nearly all of his cases were treated in the hospital wards. In answer to the statement that the treatment of fractures of the femur in dispensary practice was troublesome and not very satisfactory, and to the question whether any of his cases were treated in dispensary, he cited the case of a nursing infant fifteen days old which he had treated entirely in the out-door department by the method which he had devised, and, although the splint became more or less soiled, it did not become displaced. The child suffered very little discomfort, developed no irritation of the skin, and made a perfect recovery. Dr. Dunham said he had treated six cases in children by this method, and in all of them the bone united very promptly and with a singularly small amount of callus. In one case where the fracture occurred in the hospital ward and was promptly treated, it was impossible to feel any callus at all. One advantage of the method was that the limbs could be so easily inspected, and the course of the treatment, the deformity, etc., so carefully followed.

Stated Meeting, December 14, 1904.

The President, HOWARD LILIENTHAL, M.D., in the Chair.

RESECTION OF THE STOMACH FOR CARCINOMA.

DR. WILLY MEYER presented a man, forty-nine years old, who, when he first came under observation in May, 1904, was in a very deplorable condition. At that time he had been suffering for a number of months from vomiting, and had become greatly reduced in weight and strength. There was a distinctly palpable tumor to the right of the median line in the epigastric region, and analysis of the stomach contents pointed to a tight stricture at the pylorus.

On May 6 the abdomen was opened, revealing a large mass at and beyond the pylorus, principally involving the upper horizontal part of the duodenum. It was very firm, and there were secondary deposits in the lesser and greater omentum in the shape of many minute snow-white appearing glands. The question arose, whether to do a gastro-enterostomy or a resection. On account of the comparative youth of the patient, and the possibility of entirely extirpating the secondary deposits, it was decided to do a radical operation. Between two large clamps the stomach was divided, and almost the entire lesser curvature removed. The proximal end of the stomach was closed in the usual manner, and its cut surface inverted. In the course of closing the divided end of the duodenum by means of a purse-string suture, one of the mesenteric arteries was accidentally wounded, and caused considerable hæmorrhage. Prolonged compression failing to stop the latter, the vessel was finally singled out by compressing it between the fingers and surrounded with a catgut ligature, which was gently tied. As an additional safeguard, the head of the pancreas was placed on top of the inverted and sutured end of the duodenum. A posterior gastro-enterostomy was then done with Murphy's button, and an omental flap stitched over the duodenum and the head of the pancreas.

The patient made an uneventful recovery from the operation, and had since gained more than thirty pounds, resuming his business. The button was passed on the fifteenth day. The mass in the stomach proved to be a carcinoma.

USE OF GUTTA-PERCHA IN OPERATIONS FOR CORRECTING NASAL BONY DEFECTS.

Dr. Robert H. M. Dawbarn said he had first employed gutta-percha in operations for correcting nasal bony defects about ten years ago, and upon several previous occasions had presented patients who were thus treated to the Society. The method was essentially as follows: A strip of dentist's gutta-percha was softened over an alcohol lamp, and then, before the patient was put under an anæsthetic, it was moulded over the nose until it exactly fitted into the particular deformity presented, and corrected it. It was then dipped into ice water and allowed to harden. The patient was then placed under an anæsthetic (general); next gauze is packed in each nostril, well back, to prevent blood running into the pharynx. Then a knife was inserted into the nostril, and the skin and periosteum as far as possible stripped from the nasal bone on the side on which deformity existed; the incision being carried up as far as the nasal junction with forehead and as close as possible to the infra-orbital vessels without wounding them. Often it is necessary to enter both nostrils to do this work —when the trouble is central. Next sterile tape soaked in diluted adrenalin chloride is packed into the cavity prepared for the new bridge, until in about ten minutes all bleeding ceases and the tape is removed. Into this incision the moulded piece of gutta-percha is then slipped until it rests upon and corrects the nasal deformity. It is held in place by a small bandage on either side of the nose, and a strip of surgeon's plaster, and this completes the operation.

Dr. Dawbarn said he had now done this operation fifteen times, in one or two instances as long as ten years ago, and in every case, with a single exception, the correction of the deformity had been satisfactory and permanent, and the gutta-percha had remained unchanged and devoid of irritation. In one instance where he had endeavored to improve upon the work of the Lord, and create a Roman nose where none was intended, the tissues were stretched too tightly over the gutta-percha, resulting in inflammation of the skin, which finally broke down, revealing the gutta-percha underneath. In four of the remaining cases there was suppuration, but this soon subsided, and the final result of the operation was in no way impaired thereby. The nostril-cuts

are not sewn, and pus, if any, gravitates readily away from the new bridge.

Dr. Dawbarn said he was first induced to try this substance for the correction of nasal deformities by the suggestion of a dentist, Dr. Kimball, of New York City, who told him that he had employed it for the purpose of crowding down a non-malignant epulis, and had found it unirritating. The speaker said he considered this method preferable to that of injecting paraffin, which could not be relied upon to be permanent, and which in some instances had resulted in instant unilateral blindness, and in others had gradually changed its shape, with a poor final result. Also, the paraffin injection method inevitably causes some tension where injected, and this violates the first rule of plastic work, which is to have all structures in abundantly loose contact.

Dr. Ellsworth Eliot, Jr., said that while the method of correcting bony defects described by Dr. Dawbarn was an excellent one and a great advance in nasal surgery, he recently had a case in which he thought it would not have proved entirely efficacious. In the case referred to, instead of the usual "sunken nose" deformity, there was a decided increase in the transverse diameter of the organ. This was corrected by a subcutaneous osteotomy. An incision was made, and the two bones were forcibly crowded inward and at the same time forward.

Dr. Lilienthal asked Dr. Dawbarn whether he had tried this gutta-percha material for the purpose of filling bony defects following osteomyelitis? In those cases various paraffin-iodoform mixtures were now being used, but if gutta-percha was as unirritating as Dr. Dawbarn had described, it should be an ideal material for such purposes.

Dr. Dawbarn, in closing, said that two of his cases of nasal deformity were of the type referred to by Dr. Eliot, and the operation comprised two different steps. First, the bones were divided by narrow chisel or slender-jawed bone-forceps, and then crowded over towards the median line. After an interval of some months, to allow the inflammatory symptoms to subside, the gutta-percha plate or bridge was moulded to fit the hollow in the skin, and then was inserted, in the manner described, upon these remnants of bone as a bed.

In reply to Dr. Lilienthal, Dr. Dawbarn said that about two years ago, at the City Hospital, he operated on a case of necrosis

of the tibia. The sequestrum was removed, and the remaining bony defect, which was of considerable size, was filled with gutta-percha. Unfortunately, doubtless on account of some defect in the technique, suppuration occurred. Under proper conditions the speaker thought that this material might possibly be entirely satisfactory for the purpose of filling these bony defects, and certainly deserves a further trial.

CHRONIC LARYNGEAL STENOSIS.

DR. JOHN ROGERS presented a man, twenty-five years old, who had a severe attack of typhoid fever in 1900, followed by acute œdema of the larynx, which necessitated a tracheotomy. The acute condition gradually subsided, but left a permanent stenosis with ankylosis of one arytenoid cartilage, and the breathing became so difficult that a tracheal cannula was constantly worn. Under cocaine, the trachea was dilated with urethral sounds until a No. 45 F. was admitted. A modified O'Dwyer intubation tube was then inserted, which the patient was still wearing. The modification, which was devised by Dr. Rogers, consisted essentially of an attachment projecting at right angles from the centre of the tube through the tracheal fistula. This attachment was removable, and after the insertion of the tube was screwed into the tube through the fistula, thus keeping the fistula patent and the tube in place.

HÆMORRHOIDS.

DR. LILIENTHAL presented a young man who had recently been operated on for hæmorrhoids by the clamp and cautery method. After the masses, which were fairly large, had been clamped and cauterized, the skin was elevated at the mucocutaneous junction with the mouse-tooth forceps, and a cut radiating from the anal aperture was made with the scissors: then another and another similar cut was made, until there were five or six radiating incisions. Dr. Lilienthal said he had adopted this modification of the ordinary clamp and cautery operation some years ago, because he had found that by making these incisions there was not only no pain following the operation, but it also prevented the occurrence of dangerous œdema of the parts, with the possibility of subsequent infection.

Upon completing the operation, a dry dressing was applied,

and a light tampon tube inserted. After six hours this was replaced by a glycerin dressing.

Dr. Rogers said that about a year or two ago he saw a case in the practice of a colleague where the patient nearly bled to death after a clamp and cautery operation for hæmorrhoids. He recalled another case, seen more recently, where the patient, who gave a history of blood in the stools, was found to have hæmorrhoids, which were removed by the clamp and cautery method. Some hours after the operation, which was done out of town, the patient had a fatal hæmorrhage, and at the autopsy it was found that he had had an ulcerative colitis, and that the bleeding had come from an ulcer in the region of the sigmoid flexure.

Dr. Irving S. Haynes said he had always held the view that the pain complained of after the clamp and cautery operation was due to the fact that a bit of skin had been included in the clamp, and cauterized. In order to prevent this, it had long been his custom to divide the skin before putting on the clamp, letting the incision extend a short distance into the rectum. Since adopting this method, he had never heard the patient complain of pain after the operation.

Dr. George E. Brewer said that while he favored the clamp and cautery method, his experience with the unmodified operation had been similar to that mentioned by Dr. Lilienthal in regard to subsequent pain. Another disadvantage was the possible occurrence of a large cherry-like swelling, resulting from œdema of the mucous membrane, which the patient was apt to regard as a hæmorrhoid that had been overlooked. In order to prevent this, Dr. Brewer said he had adopted the use of a rather thick spool-shaped plug made of a drainage-tube, surrounded by gauze, and shaped so that the gauze came in contact with all the cut surfaces. This prevented hæmorrhage and infection, and by pressing the plug well upward every vestige of mucous membrane was forced inside, and the possibility of subsequent œdema avoided.

Dr. Dawbarn said he was first induced to use a rather stiff rubber drainage-tube by a disagreeable experience he had some years ago. In that instance a soft tube, wrapped with gauze, was inserted into the rectum after an operation for hæmorrhoids. On the third day reversed peristalsis set in, and the tube, with the gauze, was drawn upward into the bowel. The tube was

removed without any trouble, but, in order to extract the gauze, it became necessary to anæsthetize the patient and bring it down with much difficulty, from the sigmoid by massage plus a uterine forceps. Cathartics and enemas had been tried, but proved ineffectual. At present, Dr. Dawbarn always in such operations fastens gauze and tube for wind-passage together with a big safety-pin; and this, linked with a second pin, is secured to the dressing outside the bowel

Dr. Lilienthal said the severe pain after the usual clamp and cautery operation was probably due to the œdema in a region that was peculiarly sensitive. Dr. Haynes, in dividing the skin surrounding the tumor before putting on the clamp, practically accomplished the same purpose as Dr. Lilienthal did in making incisions radiating from the anal opening.

TRANSTHORACIC RESECTION OF THE LOWER END OF THE ŒSOPHAGUS IN A DOG, UNDER NEGATIVE AIR-PRESSURE IN SAUERBRUCH'S BOX. A PERSONAL EXPERIENCE.

Dr. Willy Meyer read a paper with the above title.

FIG. 1.—Walking on dorsum of foot. Toes distinctly backward.

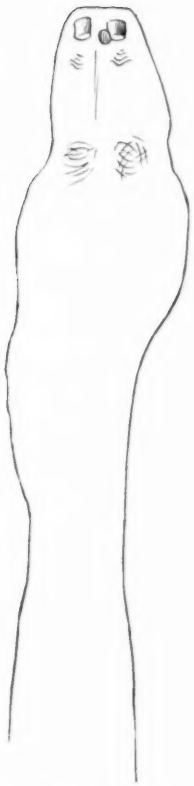

FIG. 3.—Left hand.

FIG. 2.—Congenital deficiencies of bones of foot.

FIG. 4.—Congenital deficiencies of bones of hand.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY.

Stated Meeting, December 5, 1904.

The President, HENRY R. WHARTON, M.D., in the Chair.

CONGENITAL DEFICIENCIES OF BONES OF FOOT AND HAND.

DR. DE FOREST WILLARD presented a girl, eleven years of age, an only child; no hereditary or known cause for deformities. At birth her left foot was noticed to be almost in a straight line with the leg. When she commenced to walk she was uncared for, and locomotion, until she was eleven years of age, was accomplished directly upon the dorsum of the foot, pushing the tarsus and metatarsus farther back until at time of examination she was walking with the foot absolutely reversed, the extremity of the shortened tibia being the anterior point of weight-bearing, and the dorsum of the astragalus and metatarsals being the rear point of support, the toes looking directly backward (Fig. 1). As the leg was six inches shorter than the other, from lack of development, she progressed only by bending the other knee sufficiently to accommodate the short leg. The calcaneum, as will be seen by the skiagraph (Fig. 2), had been gradually pushed up behind the tibia, and was lying horizontally to the axis of the former. Other tarsal bones absent except portion of astragalus; fibula absent. The right foot and leg were normal. The right hand had but three fingers. The left hand was a single mass like a flipper or mitten, without any division, and could not be flexed (Fig. 3). The skiagraph showed, however, that there was a rudimentary carpus and metacarpus; that the phalangeal bones of two fingers were present, with portions of the bones of the middle finger (Fig. 4).

The web was divided and the intermediate portions of bone removed; flaps were turned in and two fingers secured, which already (six weeks later) can be moved laterally sufficiently to permit the picking up of a pin, and will prove very useful.

The problem with the foot was a difficult one. An amputation would have been the simplest solution, but would have left the child with a very short leg. It seemed desirable not to disturb the lower tibial epiphysis, but to stimulate growth to adult life, or at least to puberty. To bring the posteriorly displaced os calcis to a normal right-angled position with the leg would have required resection not only of considerable portions of the tarsus, but also of the end of the tibia, and, as the leg would have still been six inches short, the use of an appliance for locomotion would have put a severe strain upon the ankle. It was therefore decided to bring the foot forward sufficiently only to permit the child to walk upon her phalanges in the equinus position, thus stimulating full growth of the leg as long as possible. An extension cork shoe, four inches thick, with lateral steel supports, will permit in time a good walking apparatus, leaving the question of amputation to be determined when adult life is reached.

The straightening process was accomplished by forcing the foot forward with powerful wrenches until the tarsus and metatarsus were brought into a forward obtuse angle with the tibia, and the phalanges were dorsal hyperextended to put them in the best position for weight-bearing. A gypsum dressing readily held the parts *in situ* for four weeks, after which walking was encouraged. As the operation was performed only six weeks since, the foot is, of course, still sensitive, but the prospects for a walking member are good.

Dr. G. G. Davis said the important point in these cases is to determine the proper time for interference. He is now caring for a child of two years who has congenital deficiency of the fibula which allows the foot to turn outward and assume a valgus position. In these cases of marked deformity one is inclined to resort to immediate amputation. In Dr. Willard's case, however, the child has kept her foot until the age of eleven, and she now seems able to support the limb upon the toes, which is superior to an artificial leg. How early is it advisable to interfere in these cases? One can either amputate or fix the foot

into a longitudinal position. These limbs do not grow so fast as normal ones, and it is advisable to use appliances which do not interfere with the epiphyses to support the child while the limb is growing. When the growth is attained, some operation of turning the foot may allow an increase of several inches in length of the limb, and avoid the necessity of an artificial leg. In his case, Dr. Davis can keep the foot at a right angle to the leg, and with the addition of a cork shoe four inches thick the child can walk, and even play with other children. Meantime the bones are growing.

EXSTROPHY OF THE BLADDER.

Dr. Richard H. Harte presented a boy, aged nine years, who was referred to him by Dr. T. S. K. Morton in April, 1901. He was fairly well nourished with a family history absolutely negative. On admission to the Pennsylvania Hospital he presented all the characteristic signs of exstrophy of the bladder, with an absence of the anterior abdominal as well as the bladder wall, causing a bulging forward of its posterior surface, the two presenting an exposed area about the size of an orange. At the bottom of this protrusion could readily be seen the ureters as two well-marked papillæ, from which the urine was discharging. The surrounding tissues were red, inflamed, and excoriated from the constant flow of urine. The penis was rudimentary and with a marked epispadias. A small hernia existed on both sides, with undescended testicles. There was apparently no lack in the bony development about the pelvis. After careful consideration of the existing conditions, it was thought that the anterior defect could be closed by a plastic operation. The method which naturally suggested itself was that recommended by Wood. Before anything could be done, however, it was necessary to get rid of all the inflamed and excoriated condition which presented around the part. The child was placed in bed with a large wet boric acid solution compress over the bladder, which was changed frequently in order to allow as little urine as possible to collect, or come in contact with the irritated surface. This condition responded quickly to treatment, and in a few days the part presented practically a normal condition. Two weeks later the patient was etherized and a bellows-shaped flap reflected from the abdomen and brought down and stitched to the bladder

margin after freshening the edges of the bladder defect. The result desired was that the handle portion of the bellows-shaped flap should correspond to and form a roof to the defective urethra. Before this flap was made, the area was outlined carefully with an aniline pencil. The tissues about the umbilicus were so thin that great difficulty was experienced in securing sufficient thickness of flap. This flap was then turned upon itself and brought out and stitched to the denuded edge of the bladder and upper surface of the penis, thus closing in the defect and leaving a fascial covered surface anterior, the cutaneous surface now forming the anterior wall of the bladder and corresponding to what ordinarily should be its mucous surface. To give a complete double cutaneous covering to the bladder, two flaps were dissected from the region of the groin and swung round upon their bases and stitched together in the median line. The upper wound was approximated as nearly as possible with silkworm-gut sutures and allowed to granulate. The sutures used to fasten the flap to the posterior portion of the bladder were buried catgut, and for the superficial stitches silkworm gut and silk were employed. The uppermost wound resulting from the flap formation was closed with harelip pins and sutures of silkworm gut. There was an incision made in the left side to relieve tension on the lateral flap, but with indifferent success, and this wound was allowed to granulate.

The time consumed by this operation was one hour and twenty minutes. There was no shock, and the child reacted well. A small, soft rubber drainage-tube was placed in the newly formed bladder and the whole surface dressed with a large, wet boric acid compress, which was regularly changed every two hours to keep the part perfectly clean and free from any urinary collection. In two weeks all the stitches were removed and the wounds were in good condition. There was a slight defect remaining at the root of the penis through which the urine escaped. The child left the hospital four months after his admission, with the understanding that a subsequent operation was to be undertaken to further perfect this local condition.

In October of the same year he was again operated upon at the Episcopal Hospital in the hopes of securing a more perfect bladder. To do this Dr. Harte dissected out the rudimentary glans from the penis, thus leaving a loose flap of skin

hanging down over the scrotum. Through this flap he made a fistulous opening with the Paquelin cautery and allowed it to cicatrize.

In March, 1902, the boy was again admitted to the Pennsylvania Hospital, and the edges of the lower flap freshened and approximated to the still defective lower portion of the bladder, and closed with two rows of stitches, the top row being buried catgut and the superficial row being silk. This flap united fairly well, with the exception of a few fistulous gaps along its margin, through which urine escaped from time to time. The patient left the hospital, but again returned in May, 1903.

At this time the edges of some of the small fistulæ were refreshed and closed with silk sutures, which proved quite satisfactory, except for a few little pin-point openings through which a little urine escaped. Finally, these openings were cauterized with a small electric cautery, and he was fairly successful in closing them. While in the hospital at this time the patient contracted the measles, so that any further operative interference was for the time contraindicated. He left the hospital in August, 1903. He returned again in the spring of 1904, when Dr. Harte succeeded in closing the remainder of these openings. He then had him measured for a urinal, which he found could be worn without any difficulty. To make this even more perfect, he is having a small retaining catheter placed in the orifice of the extemporized bladder to convey the urine down into the urinal without the escape of urine when the patient assumed a sitting posture, thus keeping the surrounding parts absolutely dry and free from urinary contact. He now attends school, and to external appearances is perfectly normal.

Dr. Harte, remarking upon this case, said that exstrophy, or extroversion of the bladder, is by far one of the most common congenital defects to be found in this viscus, and its frequency of occurrence makes it a subject of no little surgical importance. This difficulty is met with much more frequently in the male than in the female. It is attributed to many causes, none of which are fully understood, such as the rupture of the allantois during intra-uterine life, possibly as the result of a fall on the part of the mother. A more recent investigator on the subject, Reichel, bears out the theory of the older surgeons, that the majority of the malformations of the urinary bladder and urethra, and

especially clefts of these organs, are simple failures of development. These different forms of abdominal clefts and epispadias occur on account of total or partial failure of fusion on the margins of the primitive embryonic structure. It is possible that the pressure of an amnionic fold may interfere with such fusion.

The deformity, which is more common in the male, consists in the absence of the anterior wall of the bladder with a corresponding deficiency of the lower abdominal parietes, and frequently the pubic symphysis. The penis in the male is epispadic and shortened, and the clitoris in the female is split in two portions, corresponding to the nympha, the anterior commissure of the vulva being wanting, and the bladder and urethra thus opening between the labia and directly into, or immediately above, the vagina. The uterus is usually well formed. The scrotum not infrequently contains a hernia on one or both sides. The rectus muscle is usually separated and passes out to its attachment on the pubic bone. In a certain percentage of cases this separation is continued up to almost their costal attachment, in which case there is no umbilicus.

The appearance of a case of exstrophy of the bladder is quite characteristic. The posterior wall of the bladder covered with mucous membrane is pushed forward by the abdominal viscera and forms a prominent but reducible tumor in the situation of the pubes. The mucous surface, which is red, papillated, and vascular, is continuous at its periphery with the abdominal walls, the juncture being a thin cicatricial appearing edge. At the lower part of the projecting vesicular surface will be seen the orifice of the ureters giving exit to the urine by drops or sometimes a small stream. The head of the penis consists of two thick swellings, beneath which the skin hangs down in the form of an apron. The seminal vesicles with the openings of the seminal canal are visible in the posterior wall of the divided urethra. The prostate may be normal, although it is usually rudimentary and may be wholly wanting.

Treatment.—In dealing with this condition, three methods have been devised. First, removal of the bladder and suture of the ureters in the urethral gutter. Second, implantation of the ureters in the intestine, thus converting the rectum into a cloaca which will tolerate the presence of urine for long periods.

And, third, an attempt to form a new bladder by the various plastic methods.

The first method of deviating the urinary stream possesses certain advantages in its simplicity, as usually one operation will suffice, whereas by the other methods considerable time will be required to accomplish a satisfactory result. The bladder is freed and removed without opening the peritoneal cavity. The ureters are loosened for a short distance and stitched to the urethral gutter. The defect in the abdominal wall is closed by lateral flaps, which are separated below and brought to the median line. This leaves the orifices of the ureters well exposed, so that possibly they can be conveyed to a urinal, thus collecting all the urine. A simple urinal could then be worn on account of the more favorable situation of the ureters. By this operation the patient is freed from the severe pain caused by the ulceration of the prolapsed mucous membrane and from the risk of the inflammatory process extending to the kidneys. He is also enabled by this apparatus to follow many of the vocations of life, and thus become a useful member of society.

The second method, that of implantation of the ureters into the rectum, was devised by Simon, who bases his theory on the fact that in many animals a cloaca serves as a common receptacle for urine and fæces; and, further, that sometimes at birth the ureters are found opening into the rectum, and that patients, with a fistula between the bladder and rectum, in time learn to control more or less the escape of urine from the anus. In experiments on animals it has been found that the mucous membrane of the rectum was capable of withstanding the constant irritation of the urine, and that the sphincter of the rectum has succeeded in preventing its escape. In a case operated upon by Dr. Dudley Allen, of Cleveland, he was able to make use of the rectum with most satisfactory results, so that the patient was able to follow the vocation of a clerk without any apparent inconvenience on the part of controlling his urine. But, unfortunately, many of these cases thus operated upon terminate in a nephritis, owing to an ascending pyelitis, the result of microorganisms finding their way up the ureters. When this operation is resorted to, no doubt the risk of ascending ureteritis can be lessened by transplanting into the rectum an elliptical piece of the base of the bladder containing the ureters; if this portion

of the bladder is transplanted well up into the sigmoid instead of the rectum, there will possibly be less chance of infection, as this portion of the bowel is usually empty, and consequently would be free from fluid, the escaping urine quickly gravitating to the rectum. It must be remembered, however, that this operation, though very brilliantly conceived, is accompanied with no little risk as simply the result of the rather complicated operative procedure, which must necessarily be within the peritoneal cavity.

The plastic operations, varying more or less in their details, have been employed for the relief of exstrophy of the bladder with most gratifying results in many instances. To Joseph Pancoast, of this city, belongs the honor of having in 1858 performed the first successful plastic operation for exstrophy of the bladder. His method consisted in taking flaps from the groin and inverting them over the protruded organ, attaching them together in the median line, thus forming a broad granulating surface which slowly cicatrized.

Professor John Wood, of England, operated upon a large number of cases, employing the method which is usually known by his name. This was the method employed in the case presented, with a slight modification. It consists in the use of three flaps, one taken from the umbilical region and inverted over the bladder, and the other two taken from each groin and united over the first one, which they cover in. The advantage of the inverted umbilical flap is that it effectually prevents the escape of urine in the upward direction, while the groin flaps cover in the raw surface of the umbilical flap without undue tension, and, having broad bases, are in no danger of sloughing. In the case of a male it may be possible to form a roof for the urethra at a subsequent operation by inverting flaps on the newly formed covering of the bladder and from the sides of the penis. By this operation the patient is placed in a very comfortable condition. Incontinence of urine exists to a certain extent, and necessarily continues, requiring the use of a urinal or some similar contrivance, but the bladder is effectually protected from irritation and excoriation is readily prevented. The principal points which require attention in the after-treatment are to prevent tension on the flap, which encourages the contraction of the granulating surfaces; this can be done by keeping the patient in an almost sitting position, with the knees flexed over a pillow. In an

adult, trouble may be experienced by the growth of the pudendal hairs on the inverted flap; and it may be necessary from time to time to practise evulsion with suitable forceps until the inverted surface shall have lost its cutaneous character and becomes assimilated to mucous membrane. This condition, however, is not likely to occur if the patient is operated upon early in life.

To relieve the vesical catarrh and the deposit of phosphates in and about the outlet of the extemporized bladder, injections of dilute acetic or muriatic acid will be found the most satisfactory way of dealing with this sometimes annoying condition.

Dr. J. B. Roberts said he had never succeeded in closing an exstrophy of the bladder as well as the one exhibited. The nearest approach to it was one in which he made an opening for the urine in the perineum, keeping it open by rubber tubes while the bladder was closed in from the top. Several little fistulas gave trouble, as in Dr. Harte's case. A year or two after the operation the bladder was found to be completely filled with small stones; operation for their removal terminated fatally from previous involvement of the kidney by an ascending infection. Of late years Dr. Roberts is inclined not to interfere in cases of exstrophy of the bladder unless they are very large; small ones are probably better let alone. In one patient, a young lady, he had intended to transplant the ureters into the rectum, but, greatly to his satisfaction, she did not return for the operation. Dr. Roberts asked the opinion of the Academy as to the advisability of making an abdominal incision, cutting the ureters high up, and transplanting them into the small intestine.

Dr. De Forest Willard said that, when operating upon boys, the surgeon is apt to forget that hair will grow on the turned-in flap after puberty. Upon these hairs the urinary sediment will deposit and form calculi. He has secured better results by not inverting the umbilical flap. He makes it shallower than is usually recommended, and slides it down with the raw surface inward; two large lateral flaps are then made. He had found long lateral incisions of distinct value in relieving tension. Difficulty is always met in satisfactorily closing the lower part of the bladder. He considers very good the result secured by Dr. Harte. In girls and women the hair does not extend so far towards the umbilicus, and a smoother and better flap can be obtained.

Dr. John H. Gibson said the reported cases of transplantation of the ureters, with the trigone of the bladder, into the rectum seemed to indicate the lines along which future operations would be conducted. In the case exhibited, every one would admit that the plastic art had almost reached its limit, and yet the boy is still in an unfortunate condition. Early attempts at transplantation of the ureters failed, but later improvements gave better results, and the technique has now been still more improved by carrying the ureters into the sigmoid. This increases the danger of interfering with the blood-supply of the lower end of the ureters, but the operation can be safely done. If this operation continues to give as good results, plastic operations for complete exstrophy will cease to be employed.

Dr. Horwitz said that he would be inclined to regard Dr. Roberts's suggestion as a very dangerous expedient. It is well known that if a colored liquid be injected into the bladder it gradually works its way up the course of the ureter, and is ultimately found in the pelvis of the kidney. Should the ureter be cut off close to the pelvis of the kidney and anastomosed to a loop of the small intestine, the danger of the development of a pyonephrosis would be greatly enhanced.

Dr. Harte, in closing, said all surgeons recognized these cases as particularly difficult and trying. The one reported was exceptionally so, and the boy's condition when first seen was really pitiable. In considering cases of exstrophy, it is difficult to decide upon the operative method to employ. Theoretically, that of Simon seems very simple and satisfactory, but its mortality is high, and, if the patient recovers from the operation, he is almost sure to develop nephritis. Dr. Harte would regard the suggestion of Dr. Roberts to cut and implant the ureters high up as a serious and unscientific operation, as the fluid contents of the small intestine would readily pass up the ureter and produce infection. Dissecting out the trigone and transplanting it into the rectum carries along the valves of the ureters, and this tends to prevent ascending infection. If transplanted into the sigmoid, there is further advantage of the urine dropping away from the ureteral orifices; if placed in the rectum, the outlets are nearly constantly bathed in urines and fæces. In the case exhibited, Dr. Harte believes he tried to do too much at the first operation. His intention was eventually to utilize the penis

in closing in the lower part of the opening, and the umbilical flap was fashioned for that purpose, but this step was not a success. The interior of the bladder now remains in an irritated condition, and there is a tendency towards collection of phosphates, but the latter are readily removed by weak acid solutions. If a child be operated on early, the hair follicles in the inverted flap are destroyed, and there is no difficulty from this source; if done later, the hair will grow and give trouble by becoming encrusted with a deposit of phosphates.

POSTERIOR DISLOCATION OF THE ELBOW, WITH FRACTURE OF THE CONDYLES OF THE HUMERUS; REDUCTION BY OPEN OPERATION SIX WEEKS AFTER THE INJURY.

Dr. Henry R. Wharton detailed the history of a man, aged twenty-one years, who was admitted to the surgical ward of the Presbyterian Hospital, July 19, 1904, with the following history:

About a month before his admission to the hospital, he received a fall, injuring his left elbow. He was under treatment, but the nature of the treatment is not known. When admitted to the hospital, his left arm was extended and rigid at the elbow, and there was marked thickening of the tissues about the joint. There was apparent displacement backward of the bones of the forearm. This diagnosis was confirmed by an X-ray examination, which showed also a united fracture of the lower end of the humerus. Under anæsthesia, an attempt was made to reduce the dislocation which was unsuccessful.

On August 1 the patient was anæsthetized; a longitudinal incision was made over the posterior aspect of the elbow about six inches in length, and the dissection was carried down until the bones were exposed. The tendon of the triceps muscle was divided some distance above its attachment to the ulna; the capsule of the joint and lateral ligaments were freely divided, and by manipulation the bones of the forearm were drawn downward, and the articular surfaces brought into their normal relation with the humeral articulation. It was found, however, that the reduction could only be maintained when the forearm was brought into a position at a right angle with the arm, as in the healing of the fracture there had been a slight anterior projection

of the lower fragment of the humerus. After reducing the dislocation, a drainage-tube was introduced into the wound, and the capsular structure and the divided tendon of the triceps muscle were approximated with chromicized catgut suture. As the forearm had to be kept at a right angle to the arm, some difficulty was experienced in approximating these structures. The superficial wound was closed, and a plaster-of-Paris bandage was applied from the tips of the fingers to the axilla. The patient did well after the operation, and at the end of three weeks the wound was sufficiently healed to allow him to begin the attempt to make motions of the elbow-joint.

When he left the hospital, September 29, he had fair motion at the elbow-joint. Examination at the present time shows that the patient has a very slight disability of the arm, and was doing ordinary laboring work.

FRACTURE OF SECOND CERVICAL VERTEBRA, WITH RECOVERY.

Dr. Orville Horwitz exhibited a man who one year previously had sustained a fracture of the second cervical vertebra. The man had been injured by the fall of a heavy weight striking him on the shoulder and knocking him over backward, striking the back of his neck on a "roll of goods." At first he was stunned. On recovering consciousness he was enabled to get into a trolley-car and ride for a distance of about eight miles. He then walked to his home, which was about a quarter of a mile. He sent for his physician, who found him suffering from great pain and stiffness in the back of the neck. No displacement or irregularity of the spine could be detected. There was no anæsthesia or paralysis. The next morning there was complete paralysis, which lasted for about eight days. The patient was confined to the recumbent posture for about six months. It was found that he was more comfortable propped up in an armchair than he was in bed. At the present time the neck is stiff. A well-marked, hard swelling can be easily felt over the spinous process of the second cervical vertebra. He can do light work and lift about twelve pounds. The case belongs to the class spoken of by Mr. Simon as "latent fracture of the spine." A report of a number of similar cases is to be found in the literature of the

subject, notably those of Phillips, Cline, Bayard, Smith, May, Eberman, Ashhurst, Parker, and Debenham. The points of interest in the case are that an individual with so serious an injury as fracture of the second cervical vertebra should be able to ride eight miles in a trolley-car; then walk for a quarter of a mile to his home; the appearance of paralysis on the second day, which disappeared in a week, and, finally, a gradual but almost complete recovery.

Dr. De Forest Willard recalled two cases in his practice of recovery following fracture of a cervical vertebra. One was a boy who complained of severe pain in his neck, and there was slight discoverable movement of the fragments. The patient was kept for four months in a plaster neck dressing, and all the functions except rotation returned. In several other cases fracture was suspected, or at first considered certain, because of pain and rigidity, but rapid recovery indicated that the symptoms were due to hæmorrhage within the spinal canal. In Dr. Horwitz's case, however, recovery was rapid, and yet a fracture was present. A peculiar case also occurring some years ago was that of a man who, by a fall down an elevator shaft, fractured his odontoid process, yet walked fourteen squares, complaining only of severe pain in his neck. The following morning he felt so well that he wished to go back to work, but this was prevented. In less than twenty-four hours he was paralyzed below the level of the fracture, and in another twenty-four hours was dead. The odontoid was found to be broken entirely through; but displacement of the fragment did not take place until the second day, when resultant pressure on the cord caused death.

Dr. Richard H. Harte said the case reported was an illustration of the fact that severe injuries in the neck may give rise to few or no symptoms. He cited the case of a brakeman who was struck by the step of a caboose, sustaining fractures of the jaw and clavicle. This man walked more than a mile to the hospital, where his fractures were dressed and he was put to bed. He did not complain of his neck, but shortly after turned in bed and died instantly. Autopsy revealed a complete fracture of the odontoid process, and also of the bodies and spinous process of some of the cervical vertebræ. Dr. Harte believes that many fractures of the cervical vertebræ go unrecognized; the man just mentioned might have recovered from the other vertebral

fractures if the odontoid had not been broken. The X-ray now determines the presence of fractures that formerly would not have been diagnosed.

Dr. Francis T. Stewart, in support of Dr. Harte's statement regarding unrecognized fractures of the spine, mentioned two cases in which such injury was not actually suspected, but was revealed by the X-ray during a routine examination. The first case was that of a boy who had been run over by a cart and had both clavicles fractured. His neck was stiff, as would be expected in such an injury, but there were no symptoms referable to the spine or spinal cord. The X-ray showed a fracture of the arch of the sixth cervical vertebra. The boy recovered. The second case was seen some months after the receipt of injury; the neck was stiff, and the X-ray revealed a fracture of the sixth cervical vertebra. No symptoms referable to the spine had occurred, and no callus had formed. The patient could rock his head anteroposteriorly, but could not turn it from side to side.

Dr. John B. Roberts mentioned the case of a man who slipped and fell squarely on his buttocks. This was followed by paralysis of all the extremities. The man gave a history of an injury to his neck some six months before, at which time a fracture had occurred, and a finger introduced into the mouth could detect a mass in the region of the fourth or fifth cervical vertebra. The probable explanation of the paralysis after the fall is that the sudden jar tore some of the adhesions around the former injury and caused hæmorrhage. This supposition is supported by the fact that in twenty-four hours one arm had entirely, and the other nearly, regained its power. Motion of the legs then gradually returned, followed by sensation. At the end of six months he had almost perfect use of all four extremities. Dr. Roberts had considered the pressure due to blood, but he notes that Dr. Horwitz believes such palsies are caused by serum.

Dr. G. G. Davis said that, if in these cases of fracture paralysis is absolute at the time of injury, the prognosis is bad. He has seen two cases of recovery from apparent fracture of the cervical vertebræ some years after the injury. One is a man who received the fracture thirty years ago, the other a boy; both have deformity of the neck. The man has no paralysis, the boy has partial paralysis of one arm.

LUXATIO ERECTA AT THE SHOULDER.

Dr. C. N. Montgomery reported the case of a man, about sixty-four years of age, who came to the Polyclinic Hospital on the 5th of September, 1904, giving the history that two days previously he had missed his footing on a loose step in the dark and fallen, his right arm being raised in an effort to save himself. Shortly afterwards he was seen by a physician, who told him he had had a stroke of apoplexy, the limb presumably being paralyzed at that time. Since his injury he had been unable, on account of the pain, to bring his arm to within but little less than a right angle of his body. As he lay on the bed the arm was at an even higher level, his head resting on his hand, a position that secured him the most comfort. On account of the pain it could not be brought to any extent below the horizontal The head of the humerus was plainly palpable in the axilla below the glenoid cavity. There was paresis of the limb and numbness, sensation being preserved. Traction and pressure were employed for some time; but reduction did not take place till he had received a small amount of ether, when the head of the bone readily slipped into the glenoid cavity. A Velpeau bandage was applied for several days, and thereafter he received treatment at the massage clinic.

When seen about ten weeks later there was considerable wasting of the deltoid and of the arm and forearm muscles. The fingers were flexed, and there was almost no power to grip. Extension of the fingers was almost *nil*. Active pronation of the forearm was fair, but supination was much restricted. He could flex the elbow well. At the shoulder-joint movements were possible in all directions, though much limited. Forced abduction would raise the arm to an angle of only 45° with the body. There was numbness over the outer side of the biceps and back of the upper part of the arm; over the outer side of the elbow and back of the forearm and wrist, not over the hand. Pricking with a pin-point over this area produced a numb sensation.

The marked elevation of the arm in this case of subglenoid dislocation, and the difficulty experienced in attempts to lower it, together with the findings of the radiograph, established the diagnosis of luxatio erecta. This rare condition was first

described by Middledorpf and Scharm in 1859. Stimson had been able to collect only eleven cases up to 1899, and Vaughan reported a case in April of this year. It is of interest to note the primary diagnosis of apoplexy, and the effects on the brachial plexus following the two days' pressure before reduction was performed.

Dr. G. G. Davis believes that nearly all dislocations of the shoulder are subcoracoid instead of subglenoid. In all cases the head of the humerus comes out anteriorly to the long head of the triceps muscle. The width of the head covers the entire distance between the long head of the triceps below and the coracoid process above, and moves forward more than downward. The head of the bone is felt in the axilla, even if the dislocation is subcoracoid.

STRANGULATED GANGRENOUS PERFORATED FEMORAL HERNIA WITHOUT SYMPTOMS, COMPLICATED BY SUPPURATING ADENITIS.

Dr. George G. Ross reported the case of a young woman, aged seventeen years, who had a good family and previous personal history. For one year prior to the trouble under consideration, she had had occasional attacks of pain in the right iliac fossa, never severe enough to confine her to bed.

Three days before admission, she noticed a swelling in the right groin, which was painful and tender. On the following day the pain had increased, and the mass had become red and very tender. On the day of admission the pain was severe, radiating to the right side of the abdomen and down the right thigh. She had one attack of vomiting during the three days. The bowels had not been opened for two days.

On admission the temperature was 101.2° F.; pulse, 100; respirations, 28. Physical examination proved that the heart and lungs were normal. The face was flushed and anxious. The tongue was coated. There was a painful, tender, red, fluctuating mass in the right groin, the pain of which extended to the abdomen and thigh. The patient gave no venereal history or evidences of a venereal lesion. There were no abrasions or foci of infection of the extremity.

Calomel and salts were given, and acted promptly and thor-

oughly, without pain or marked discomfort. The patient had not vomited or complained of nausea during her stay in the hospital.

A diagnosis of suppurative inguinal adenitis was made, and excision of the inflamed glands was decided upon. A three-inch incision, parallel to Poupart's ligament, was made. There was exposed a mass of suppurating glands, several of which ruptured during the dissection. As the dissection approached the saphenous opening, it became apparent that there was something more than a simple adenitis to be dealt with. Further search revealed the sac of a femoral hernia containing gangrenous gut with a perforation. When this sac was opened, a fæcal odor escaped. A ligature was thrown about the strangulated gut and securely tied. A median abdominal incision was made, and the gut with the ligature was drawn into the abdominal cavity. Unfortunately, the femoral canal was too small to transmit the ligated gut, and the ligature pulled off, permitting the escape of a small amount of fæcal matter into the peritoneal cavity. An examination of the involved gut proved it to be a part of the cæcum,—the portion between the ileocæcal valve and the appendix, which was placed well to the outer side. This fact accounts for the lack of symptoms of strangulation, as the fæcal circulation was not in the least interfered with.

The opening in the cæcum was closed with Lembert sutures; the peritoneal cavity was flushed, and the wound was closed without drainage. The femoral ring was closed with a purse-string suture, and the lower, or original, wound was closed with silkworm-gut sutures. A gauze drain was inserted, the end coming out at the lower end of the wound. The patient made an uninterrupted recovery.

GANGRENE AND PERFORATION OF THE SMALL BOWEL FOLLOWING RADICAL OPERATION FOR DOUBLE INGUINAL HERNIA.

Dr. Ross also reported the following case: A man, aged fifty-seven years, had worked hard all his life, and used alcohol and tobacco in moderation. He had enteric fever and influenza some years ago. His general health, appetite, bowels, etc., were in good condition. He had double direct incomplete inguinal

hernia of fifteen years' standing; and while he said that this had caused very little pain, it had annoyed him so much that he had not been able to work for six months. The heart and lungs appeared to be normal, and an examination of the urine on several successive days showed nothing abnormal in either quantity or quality. He had an arcus senilis and some demonstrable sclerosis of the radials.

Radical operation was advised and accepted. Accordingly, both sides were repaired. It proved to be a double direct incomplete hernia, presenting no difficulty to correct. The sacs having a broad base were sewed instead of ligated. Neither the bowel nor the omentum was handled, as there was no necessity for so doing.

The day following the operation the patient complained of severe abdominal pain. He was very restless and had an anxious expression. The bowels moved and he expelled flatus frequently. On the two succeeding days his condition remained much the same. There were pain and restlessness, with intervals of quiet and sleep, the bowels moving and passing flatus. On the fourth day he had a bowel movement. He still complained of pain and was very restless. The abdomen was distended. On the fifth day his condition was about the same, except that the temperature rose to 103.2° F.; pulse, 36; respirations, 32. At 4.30 P.M. he expelled flatus, although the abdomen was still distended. He died of peritonitis at 5.35 P.M.

A partial post-mortem through the incisions was made, and the conditions found were as follows:

The incisions had both healed by first intention. The parietal peritoneum was not adherent to the bowel, either by inflammatory adhesion or by stitches. When the peritoneal cavity was opened, a greenish-yellow fluid, containing flakes of lymph, exuded; and the ileum was covered with irregular patches of greenish-yellow exudate, one metre from the ileocæcal valve. The ileum was gangrenous for about twenty-five centimetres, in the centre of which was a perforation four millimetres in diameter. The surrounding intestine was reddish-black. There was a considerable amount of exudate in the lower pelvis. The left kidney was normal. The right showed pale, cortical and medullary substance diminished in amount.

Owing to haste, the mesenteric vessels were not examined

carefully for a thrombus. Nevertheless, the reporter believed that this was a case of clogging of the mesenteric arterial radicle of the involved bowel with thrombus due to arteriosclerosis.

VESICAL CALCULUS WITH NUCLEUS OF CHEWING GUM.

Dr. William J. Taylor exhibited the fragments of a calculus he had removed from the bladder of a boy of eighteen years. One year ago the boy had gonorrhœa, and, to prevent the discharge, had inserted into the penis several masses of chewing gum. These passed into the bladder and induced cystitis. The boy had drifted about under the care of quacks and homœopaths during the year, and calculi had formed upon the gum, four distinct masses of which were removed. Removal through a perineal incision was attempted, but the masses were too large, and a suprapubic operation was necessary. The masses were crumbled in their removal.

Dr. G. G. Ross cited the case of a man, the father of five children, who claimed the use of a catheter was necessary. He lost the catheter, and to replace it he moulded a piece of chewing gum around the end of a stick, which he inserted through the urethra. It became dislodged by the body heat, and was located in the bladder by the cystoscope and removed through a suprapubic incision. The gum had been in the bladder three weeks, and was found encrusted with salts.

Dr. Horwitz called attention to a somewhat similar case that he had reported some four years ago, in which 280 grains of white wax had been removed from the urinary bladder by means of a suprapubic cystotomy. On admission to the hospital, the individual stated that the wax was in the bladder, but gave rise to no symptoms. Examination of the urine was negative. The mass was easily seen by means of the cystoscope. The wax had been inserted into the urethra, previous to intercourse, for the purpose of preventing pregnancy, and slipped into the bladder whilst performing the sexual act.

CORRESPONDENCE.

CORRIGENDA IN RE BONE TRANSFERENCE.

EDITOR ANNALS OF SURGERY:

In the February issue of the ANNALS I regret to find that in the "Report of a Case of Bone Transference," page 250, Figures 2 and 3 have been transposed. Fig. 2 as it now stands should read: "Fig. 3. Radiogram showing condition of bone thirteen months after operation." Fig. 3 should read: "Fig. 2. Radiogram showing condition eight months after operation." Will you be kind enough to make this correction in the next issue, as I believe the case is of sufficient importance to warrant an accurate chronological record?

THOS. W. HUNTINGTON.